SEABIRD MONITORING HANDBOOK

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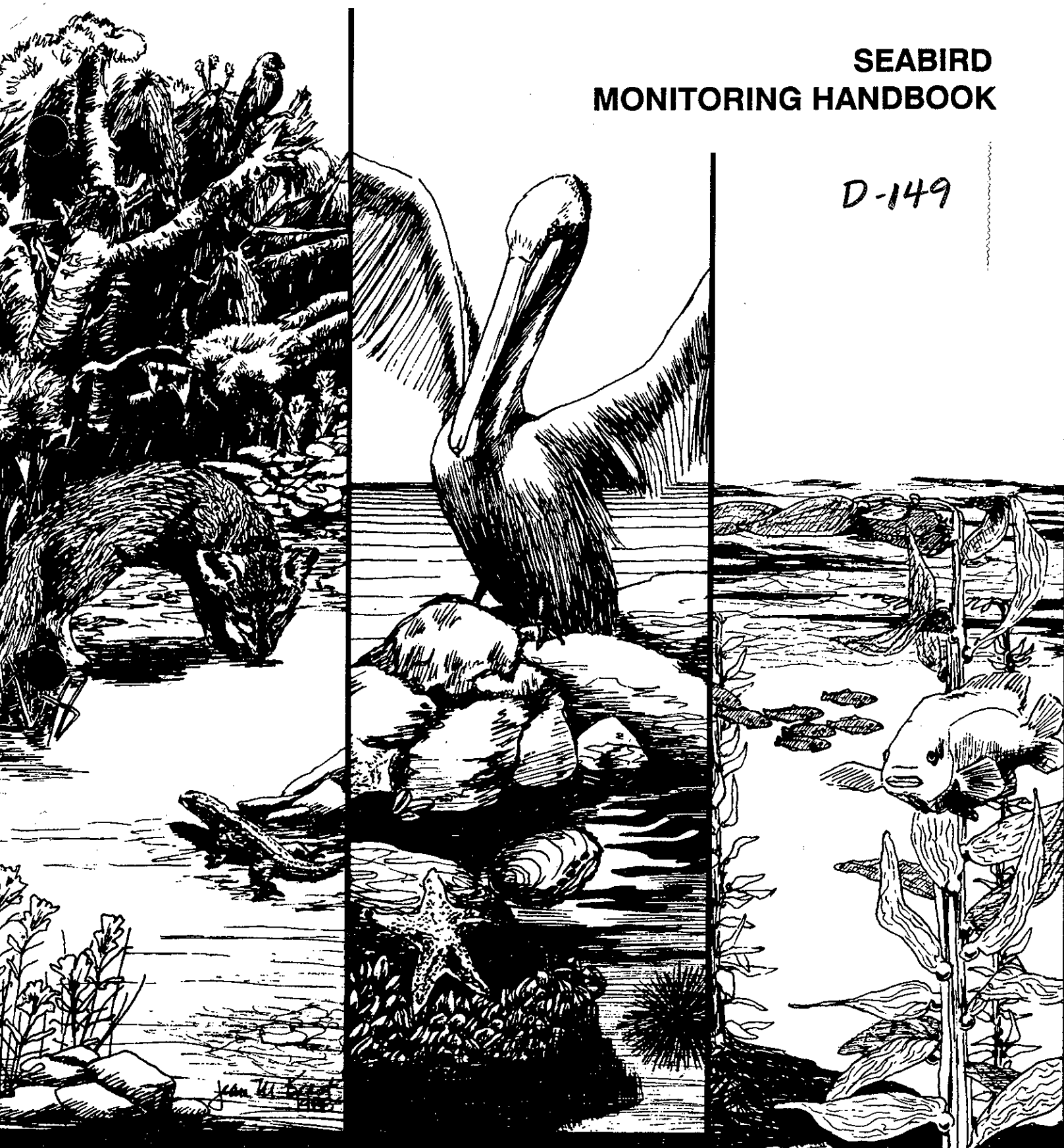

Channel Islands National Park

National Park Service
U.S. Department of the Interior

SEABIRD MONITORING HANDBOOK

CHANNEL ISLANDS NATIONAL PARK CALIFORNIA

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PREFACE TO REVISED EDITION

This revision of the original seabird monitoring handbook, published in 1983, resulted from four years' field experience (1985-1988) conducting the monitoring program. Many of the techniques described in the original handbook had not been extensively field tested prior to our efforts, and many techniques used in long-term investigations had to be scaled down from research-approach levels to monitoring levels. It was therefore not surprising to encounter unanticipated problems in carrying out some of the prescribed tasks set forth in the first edition. This revision identifies the problem-areas and incorporates newer techniques and revised methodology to refine and streamline the seabird monitoring program. Updating a manual such as this is, of course, an ongoing process and is subject to the bounds of our perceptions and the constraints and inconvenience of limited resources. No doubt techniques for seabird monitoring at Channel Islands National Park will continue to evolve as new methods are incorporated and solutions to new problems are found.

DBL and FG
August 1988

ACKNOWLEDGEMENTS

(First Edition, 1983)
We thank the many persons on the staff of the Channel Islands National Park for their assistance and cooperation, especially Gary Davis, Charles Drost, Jack Fitzgerald, George Leone, Chuck Scott, Patricia Scott, and Don Unser.

Jim Sayce and Audrey Martin helped clarify questions about methodology. Noelle Congdon, Fran Enright, Jerry Kaiwi, Ann Killam, and Jim Sayce assisted with field work on Santa Barbara Island. Jerry Kaiwi offered help with questions on data management and improved earlier drafts of the handbook. Karin Christensen drew the illustrations. We appreciate all of these contributions.

Financial support was provided by National Park Service (contract number CX 8000-1-0035) to University of California; California Department of Fish and Game; the U.S. Fish and Wildlife Service; School of Biological Sciences, University of California, Irvine; Department of Wildlife and Fisheries Biology, University of California, Davis; and California Institute of Environmental Studies.

(Revised Edition, 1988)
Since the inception of continuous monitoring activities in 1985 many people have contributed to the development of the Channel Islands National Park seabird monitoring program. Charles Drost in particular has provided valuable insights and meticulous data collection on Santa Barbara Island seabirds. The burden of having to be present on several islands at once, particularly during midsummer breeding peaks, was greatly alleviated by the assistance of Channel Island personnel. Island rangers at Santa Barbara Island (Reed McLuskey, Corky Farley, Dave Salas, and Leslie Patterson), Anacapa Island (Jack Fitzgerald, Yvonne Menard, Don Unser, Chris Pergiel, and Ralph Moore), and San Miguel Island (Rob Danno and Tom Cox) not only helped with logistical support on "their" islands but also kept us informed of changing events in our absence, and in some instances collected data. Resource Management seasonal employees (Heidi Cogswell, Gary Ludwig, Janine Lombardi, and Nancy Karraker) each endured the drudgeries of the Anacapa rat patrol and the terror of gull grids for the promise of brief glimpses of Prince Island's wonders. Channel Island National Park boat operators (Pat Given, Dwight Willey, Dave Stoltz, and Randy Bidwell) almost always got us to the islands on schedule, and dispatcher Karen Johnston has now suffered four seasons of miasmic scheduling situations with her sense of humor largely intact. A host of seasonal Interpretive Specialists and unpaid volunteers also contributed to our field efforts. Managerial support within Channel Islands National Park has come from Frank Ugolini, Bill Ehorn, Tim Setnika, Gary Davis, and Bill Halvorson. Outside advice and aid from W. Breck Tyler of UC Santa Cruz, George L. Hunt, Jr. and Zoe Eppley of UC Irvine, Daniel W. Anderson, Michael Fry, and Mark Sogge of UC Davis, Raymond Pierotti of UC Santa Barbara, and Bob Boekelheide and Gary Page of Point Reyes Bird Observatory was particularly valuable in the continuing development of the seabird monitoring program. We are grateful for the efforts of all these people and to those we have not named who contributed to the success of this project.

DBL, FG
August 1988

INTRODUCTION

The purpose of this handbook is to outline a methodology for monitoring selected seabird species in Channel Islands National Park. The methods have been derived from both long-standing studies of certain species and recent work with other birds not monitored in the past. Consistent with Channel Islands monitoring goals, the data will be used to detect changes in populations over a period of time rather than to determine the cause of such changes. To detect these changes, important parameters included in the seabird monitoring program are:

- abundance of breeding birds
- reproductive success
- phenology, and
- population age structure.

All of these reflect important trends in population dynamics. The number of breeding birds may represent either reproductive effort or adult population size; changes in either category affect the total number of young recruited to the population. Reproductive success is measured by the number of fledged young, and is the most direct measure of the addition of young to the population. Chick survival can be affected by changes in phenology (timing of egg-laying, hatching and fledging). Age structure represents relative numbers of non-breeding juveniles and breeding-age adults in the population; changes in this parameter affect the number of breeding attempts and recruitment of young. When available, other parameters such as food use and chick growth rates are valuable to measure because they provide data for interpreting observed changes in a biologically meaningful way.

Despite the benefits of a program containing the parameters outlined above, experience has shown that practical considerations often limit the number of parameters that can be effectively measured as well as the number of species monitored. For instance, the particular measurements taken for a given species may be limited by nesting habits, response to human intervention, experience of personnel, and time and monetary constraints. Similarly, of the eleven seabird species that nest in Channel Islands National Park, only six can reasonably be monitored; difficulties such as inaccessible nests, nocturnal behavior, and variable breeding sites preclude using the others. This handbook, then reflects a compromise between an ideal monitoring program and a practical one.

MONITORING DESIGN CONSIDERATIONS

In designing effective techniques to monitor seabirds on the Channel Islands, decisions were made as to which species would be monitored, the islands on which they would be monitored, parameters to be measured, and reasons for these choices.

CHOICE OF SPECIES

Table 1 shows the spatial distribution of the eleven seabird species that nest in Channel Islands National Park. Several species were eliminated as monitoring targets primarily because certain aspects of their biology preclude obtaining reliable data. The three species of storm-petrel (Leach's Storm-Petrel *(Oceanodroma leucorhoa)*, Ashy Storm-Petrel *(O. homochroa)*, and Black Storm-Petrel *(O. melania)*) are nocturnal and secretive, and their breeding phenology and biology on the Channel Islands are poorly documented. It is therefore probably too costly to collect quality information for these species. Of the three cormorant species, Brandt's Cormorant *(Phalacrocorax penicillatus)* is probably unsuitable for monitoring. Although abundant and widespread throughout the islands, this species frequently shifts nest sites, making data collected from samples difficult to interpret.

Of the three alcid species that nest here, Pigeon Guillemot *(Cepphus columba)*, Xantus' Murrelet *(Synthliboramphus hypoleuca)*, and Cassin's Auklet *(Ptychoramphus aleuticus)*, the guillemot is the most difficult to monitor. This species nests in caves, making it very awkward to determine the size of the nesting population or measure other important parameters. The following species have, there-

fore, been chosen for the monitoring program:

- California Brown Pelican *(Pelecanus occidentalis californicus)*
- Double-crested Cormorant *(Phalacrocorax auritus)*
- Pelagic Cormorant *(Phalacrocorax pelagicus)*
- Western Gull *(Larus occidentalis)*
- Xantus' Murrelet *(Synthliboramphus hypoleuca)*
- Cassin's Auklet *(Ptychoramphus aleuticus)*

The selected species are diverse and provide broad geographic coverage of the park islands. Some are sensitive to oil or chemical pollution, changes in food availability and abundance, and human disturbance; changes in these populations may suggest a more widespread problem affecting other species as well. Most of these species also have existing baseline data for certain parameters with which comparisons of future data can be made.

California Brown Pelicans breed predictably on the north slopes of West Anacapa Island each year and build large nests that are observable from a distance. Double-crested Cormorants rarely change island colony sites and their nests are also conspicuous. Although both species are highly vulnerable to the effects of disturbance, accurate and reliable data can be collected at a distance for each. Pelagic Cormorants, at the southern extreme of their range, breed in small numbers on the Channel Islands and hence were not initially included in the Seabird Monitoring Program in 1982. Since 1984, however, they have consistently nested on Anacapa Island where sub-colonies have been accessible and easily censused. Although this is a small breeding population, it has expanded since its inception, and data on abundance of breeding adults, reproductive success, and phenology can be easily obtained for monitoring purposes. Western Gulls are highly visible surface nesters and, compared to cormorants and pelicans, are much less sensitive to human disturbance and thus are readily studied. Xantus' Murrelets nest in crevices and small caves that are usually accessible with minimal disturbance. Cassin's Auklet, a burrowing species, is locally the least known of the targeted species. Monitoring this species, although somewhat difficult, is worthwhile because the site of its largest colony, Prince Island, supports the greatest number of seabirds in the park, they are primarily plankton-feeders (unlike most other monitored park seabirds), and they are likely to be sensitive to oil pollution (and may therefore be a good indicator species).

In addition to these six seabird species, monitoring the Snowy Plover *(Charadrius alexandrinus)*, a shorebird which nests on San Miguel, Santa Rosa, and Santa Cruz islands will begin during the 1989 breeding season. The Snowy Plover is listed by the State of California as a "Species of Special Concern" (Remsen 1978) and information about its breeding biology and abundance in Channel Islands National Park is currently very limited.

Ancillary observations of breeding season activities of Brandt's Cormorants, Pigeon Guillemot and Xantus' Murrelets should be made when the opportunity arises as follows:

Brandt's Cormorant nesting should be documented each year on Santa Barbara, Sutil, and Prince islands. This species nests consistently at Prince Island, in small caves and on the cliff ledges of Webster Point on Santa Barbara Island, on the north ledges of Sutil Island, and on Gull Island. These areas can be surveyed by boat once or twice each breeding season for the presence of nests, although accurate nest counts or observations of nest contents are often difficult. Brandt's Cormorants also nest rarely on West Anacapa Island (at Sea Lion Cove in 1970 and Rat Rock in 1982), and should be looked for in the course of monitoring activities. If consistent breeding occurs, routine monitoring of this species should be incorporated into the program.

Pigeon Guillemot numbers in the nearshore vicinity of Anacapa, Prince, and Santa Barbara islands should be noted in the course of other monitoring activities as a relative index of breeding effort. Counts are best done during June and July when adult birds are tending young which no longer require the constant presence of an adult at the nest. Adults at this time are easily observed flying in and out of the nesting caves and in pairs on the water as they forage. Data on number of pairs breeding have been collected annually on East and West Anacapa islands since 1982; annual breeding records should be maintained.

Table 1. Distribution of Seabirds Nesting in Channel Islands National Park (from Hunt et al. 1980).

FAMILY	SPECIES	ISLAND				
		ANI	SBI	SCI	SMI	SRI
		(see key below)				
Storm-Petrels Hydrobatidae	Ashy Storm-Petrel (*Oceanodroma homochroa*)		A	A	L	?
	Black Storm-Petrel (*O. melania*)		L	?		
	Leach's Storm-Petrel (*O. leucorhoa*)		?	?	L	?
Cormorants Phalacrocoracidae	Brandt's Cormorant (*Phalacrocorax penicillatus*)	O	A	A	L	A
	● Double-crested Cormorant (*P. auritus*)	A	A		L	
	● Pelagic Cormorant (*P. pelagicus*)	A	O	A	L	A
Pelicans Pelecanidae	● California Brown Pelican (*Pelecanus occidentalis californicus*)	L	A	O	O	
Gulls Laridae	● Western Gull (*Larus occidentalis*)	L	A	A	A	A
Alcids Alcidae	● Cassin's Auklet (*Ptychoramphus aleuticus*)		A	A	L	
	Pigeon Guillemot (*Cepphus columba*)	A	A	A	L	A
	● Xantus' Murrelet (*Synthliboramphus hypoleuca*)	A	L	A	A	

Key: **ANI** = Anacapa Is. **SBI** = Santa Barbara Is. including Sutil Is. **SCI** = Santa Cruz Is. including Gull Is. and Scorpion Rock

SMI = San Miguel Is. including Prince Is. **SRI** = Santa Rosa Is.

Distribution:
A = Active Colony
O = Occasional Colony
L = Largest Colony
? = Probably Present
● = Monitored Species

Xantus' Murrelets almost certainly nest in the Arch Rock/Landing Cove area of East Anacapa Island. Adult birds are consistently heard calling from the water beneath the cliffs in April, May, and June; adult pairs are seen in the vicinity prior to breeding season; and a newly fledged chick was observed at Arch Rock in June 1985. Surveillance for the presence of this species on East Anacapa, including estimates of numbers of calling birds from the cliff tops between the Landing Cove and the southward bend in the service road should be maintained.

CHOICE OF ISLANDS

The recommended island monitoring sites for the selected species are shown on Table 2. While it may be desirable to monitor the birds on all the islands where they occur, small population sizes or difficult access make this inadvisable if not physically impossible. The following selected colonies are relatively accessible and provide broad coverage:

CHOICE OF PARAMETERS

For practical reasons, the recommended parameters (breeding bird abundance, reproductive success[1], phenology, and population age structure) can not be measured for all the selected species. Of major concern in choosing the parameters is the potential disturbance and consequential breeding failures for both target species and other birds nesting in the same area. Pelicans and cormorants are particularly sensitive to human disturbance and for other species, such as murrelets and auklets, existing population sizes may be too small on some islands to risk regular monitoring. Due to variable disturbance potentials at different sites the number of parameters measured changes with species nesting locations. For example, whereas three of the suggested parameters may be possible to measure for Double-crested Cormorants on Anacapa Island, only one can likely be measured for this species on Prince Island (see Table 3).

Table 2. Island Monitoring Sites for Selected Seabirds/Shorebird in Channel Islands National Park.

	ANACAPA ISLAND	GULL ISLAND	PRINCE ISLAND	SANTA BARBARA ISLAND	SAN MIGUEL ISLAND
Double-crested Cormorant	X	Not present	X*	X	Not present
Pelagic Cormorant	X*	Not present	Too difficult	Not present	Not present
California Brown Pelican	X*	Not present	Not present	X	Not present
Western Gull	X*	X	X	X	Not present
Xantus' Murrelet	Too few	Too few	Too difficult	X*	Not present
Cassin's Auklet	Not present	Too difficult	X*	Too few	Not present
Snowy Plover	Not present	Not present	Not present	Not present	X

* Largest colony in Channel Islands National Park.

[1] Variously defined, but usually one of the following: a) percent fledging of hatched chicks (fledging success); b) percent fledging of eggs laid (reproductive success); c) number of chicks fledged per nest (productivity); or, d) the number of chicks fledged per colony (total productivity).

SOURCES OF VARIABILITY

As highly mobile animals, seabirds fluctuate in numbers with respect to time of year, activities within seasons, and time of day. An effective monitoring effort must attempt to account for the variation caused by these natural fluctuations, as well as that introduced by observer error, and then distinguish between these sources of variability and those owing to changes in the environment. The following guidelines are recommended to minimize the observer sources of variability:

Table 3. Recommended Parameters to Measure for Selected Species in Channel Islands National Park.

	ANACAPA ISLAND	GULL ISLAND	PRINCE ISLAND	SANTA BARBARA ISLAND	SAN MIGUEL ISLAND
California Brown Pelican	Breeding birds Reproduction Phenology			Breeding birds Reproduction Phenology	
Double-crested Cormorant	Breeding birds Reproduction Phenology		Breeding birds	Breeding birds Reproduction Phenology	
Pelagic Cormorant	Breeding birds Reproduction Phenology				
Western Gull	Breeding birds Reproduction Phenology Age Structure Food use Growth rates	Breeding birds	Breeding birds Reproduction Phenology	Breeding birds Reproduction Phenology Age Structure Food use Growth rates	
Xantus' Murrelet				Breeding birds Reproduction Phenology	
Cassin's Auklet			Breeding birds Reproduction Phenology		
Snowy Plover					Birds on beach Females on beach

MEASUREMENTS

Defining measurements carefully is one of the most important ways to control variability. Ambiguous counting units or ones for which a subjective decision must be made are a common source of error even among experienced counters. We have attempted to be precise in defining the measurements for each parameter, but even these may be subject to change if more specificity is required.

OBSERVERS

Even with well-defined counting units, observer error is inherent in seabird censusing. Continuity of experienced observers is required for accurate censusing (Richardson et al. 1981; Harris and Murray 1981). This is especially true when counts must be obtained from a long distance (e.g., Brown Pelican observations, and Western Gull total nest count on Santa Barbara Island). If observers change, then the departing observer should train the incoming observer to maintain a minimal level of continuity. Incoming observers should have prior experience censusing seabirds, or, at the least, censusing of animal populations in the field.

COUNTING

Proper monitoring requires careful observations to minimize sampling error. Methods used for long-distance censusing must be consistent from year to year for all species and measurements. When censusing a particular area or sample of the population, it is recommended that when multiple observers are available, they count independently, record results, and recount the same area. Results should not be discussed among observers prior to the second count, as doing this will prejudice the recount. All counts may then be averaged for an estimate of the sample mean. This counting method allows calculation of observer variability. When a single observer is present, recounts should routinely be made and averages taken. Counts obtained from close-range work (e.g., in established grids or transects, or from areas of low population density), do not require repeating.

Counts made from boats can be especially difficult. Observers must be experienced to maintain count continuity and reasonable accuracy in a moving vessel in unstable conditions. Multiple counts using inexperienced observers may introduce greater potential for misleading results than single counts by someone experienced in censusing from a vessel. Counts obtained from close-range work (e.g., in established grids or transects, or from areas of low population density), do not require repeating.

TIMING OF COUNTS

One approach recommended throughout this manual and also used by others attempting to deal with natural fluctuations in seabird numbers (Lloyd 1975; Richardson et al. 1981; Harris and Murray 1981), is to census during a particular stage of the breeding season. The distribution of seabirds during the non-breeding season is highly variable and difficult to interpret. Monitoring efforts are thus focused on breeding birds, which predictably gather in colonies at certain sites each year to mate and raise young. Also, the diurnal patterns of colony attendance fluctuate depending on the stage of breeding and time of day. Knowledge of breeding behavior is therefore necessary for determining the optimum census times, (i.e. when attendance is most stable). Lloyd (1975) found that daily attendance of razorbills and guillemots became less variable as incubation progressed and was most stable during the nestling period (from hatching to fledging). Similarly, for Western Gulls, the most stable period is after peak egg-laying; during this 7 to 10 day period, most gulls have laid eggs and the first young are hatching, so counts of birds on nests (to estimate pairs) will be most accurate. The pattern of colony attendance also varies for some species within a single day, and censuses should be timed accordingly. Consistency is of key importance - once a time for counts is chosen, adhere to it as much as possible.

DISTURBANCE

Disturbance during a critical time in the breeding cycle can have severe detrimental effects by causing injury, direct mortality of young, and nest abandonment. Predation by gulls or ravens on unattended eggs and chicks is often a serious consequence of human disturbance. Monitoring personnel must be extremely cautious and follow outlined procedures for approaching observation points and working in or near seabird colonies.

WEATHER

The influence of weather conditions on monitoring is discussed in the species accounts, but note that good weather is required for good counts no matter how precise one's timing or how experienced the observers. Weather also influences colony attendance by seabirds; thus, when possible, make counts under similar conditions each time, but avoid censusing in adverse weather conditions (e.g., high winds or heavy fog) which will obviously hamper observations and compromise data.

MONITORING PROTOCOL

SAMPLING METHODS

The methods suggested in this section were derived from long-term research on specific populations (Brown Pelicans and Double-crested Cormorants on Anacapa Island; Western Gull and Xantus' Murrelet on Santa Barbara Island) and from work during the 1982 field season which developed methods for previously unstudied populations. These methods have since been tested during subsequent field seasons. Cassin's Auklet monitoring methods were developed in 1986, as modified from ongoing studies of this species on the Farallon Islands by Point Reyes Bird Observatory and University of California at Davis researchers. Snowy-Plover monitoring methods have evolved over several seasons (1985-1988). Since some methods, such as those for Snowy Plovers, still require more testing, they should not be considered inflexible or as the final word on monitoring techniques. Year-to-year variability may dictate improvisation or revision of methodology, and any method is subject to modification with respect to practical problems encountered in the field.

This methods section is organized first by species, then by island. The following is an outline of the basic format for each species shown in actual type styles used within the text. (To avoid unnecessary repetition, certain categories have been omitted when not applicable.)

SPECIES

BREEDING BIOLOGY AND PLUMAGE

FIELD METHODS BY ISLAND

(Table showing...)
Parameters and Measurements

Areas to be censused

Methods

Potential Problems

Recommended Methods

Boat Surveys
Land Surveys
Locating Colonies
Abundance of Breeding Birds
- total nest count
Reproductive Success
- sample chick count
Chick Mortality
- post season nest count
Phenology
Age Structure
Band Sightings
Monitoring Schedule

Monitoring Schedule

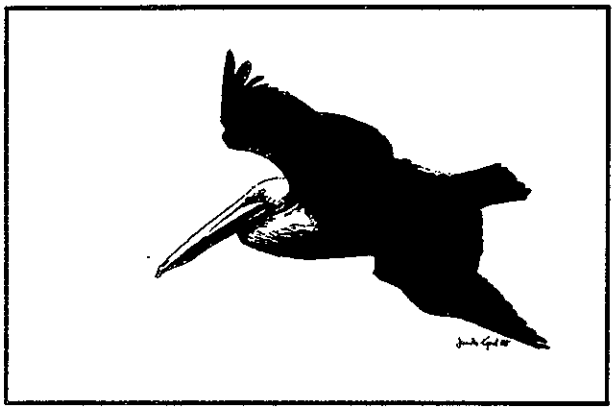
Time Required

Recording Data

Safety

Special Equipment

CALIFORNIA BROWN PELICAN



BREEDING BIOLOGY AND PLUMAGE

West Anacapa Island is the site of the largest and most consistent Brown Pelican nesting colony in southern California (Figure 1). The historical records suggest that pelicans nested here nearly every year, while at other colony sites (Santa Barbara Island, Scorpion Rock, and Prince Island), nesting is ephemeral or irregular (see Gress and Anderson 1983; Hunt and Ingram 1982). Nesting on Santa Barbara Island, however, may have occurred much more frequently than the scant historic records indicate. No pelican nesting was reported on Santa Barbara Island for at least 25 years prior to 1980 (Gress and Anderson 1983); however, nesting occurred in 1980, 1983, and 1985-88 (Figure 4) (Anderson and Gress 1983; Lewis and Gress MS; Sowls et al. 1980).

Brown Pelicans are colonial nesters, building large bulky nests on the ground or in shrubs. Nests from previous years generally remain unused or a new nest may be built on top of an old one, but most often an entire new nest platform is built each year. Colony sites may be used in consecutive years or new areas may be colonized. Nesting may be a synchronous effort or may consist of several asynchronous units (sub-colonies) established over a period of several months in one or several locations on island colony sites.

Since 1969, when continuous observations began, the earliest breeding on Anacapa and Santa Barbara islands was initiated in mid-December; the latest date for initiation of nesting during the same period was mid-May (Anderson and Gress 1983; Gress and Anderson 1984; 1985; Lewis and Gress MS).

Brown Pelicans generally begin breeding when 3-5 years old (occasionally a sub-adult will nest, but their breeding success is usually lower). Pair bonds are formed at the nest site and eggs are usually laid about one week after commencement of courtship and nest-building. The clutch nearly always consists of 3 eggs; both parents participate in incubation during which they never leave the nest unattended unless the nest is abandoned. The incubation period is about 30 days.

Newly-hatched chicks are altricial; they are unable to hold their heads upright and are helpless for 5-7 days after hatching. They require constant protection from temperature extremes and predation until about 3 weeks of age. Both parents participate in feeding the young. Nest abandonment and starvation of young occur when food resources are scarce, resulting in reduced breeding success and lower mean brood size. Chicks up to about 5 weeks old generally stay on or near the nest site; older chicks tend to wander farther from the nest and will often gather in small groups (creches). Chicks from the same brood, however, tend to stay together and will remain loosely attached to the nest site. Fledging occurs at 11-14 weeks of age (13 is typical). Once young birds leave the colony they rarely return, although fledglings often beg from adults while roosting in the colony area and gather in loafing groups during the period immediately following fledging. These groups occupy the shoreline or waters close to the colony site, remaining from several days to several weeks.

There is little evidence (based on plumage characteristics, color of soft parts, and behavior) that California Brown Pelicans regularly lay a replacement clutch if the first clutch is destroyed or abandoned; renesting rates, therefore, are probably negligible. The 1978 breeding effort on Anacapa Island appears to be the only year since studies began in 1969 in which significant renesting occurred (Anderson and Gress 1983).

Brown Pelicans have highly complex plumage sequences and molt somewhere on their bodies throughout most of the year. There are three molts and three feather generations per year as shown in Appendices A-2 and A-3. Breeding plumage is attained prior to onset of courtship behavior with a molt of head and neck feathers and is characterized by a dark neck stripe and chest. They begin a full body molt while raising their young with "winter"

plumage characterized by a white head and neck. Additionally, coloration of the pouch, bill, feet, legs, bare skin, etc., also varies with season. One of the most striking color changes is the bright red pouch attained by adults of both sexes at the onset of breeding; the pouch color begins fading soon after eggs are laid and incubation begins. Subadults will occasionally show red on their pouches as well.

Complete descriptions of both adult and chick-plumage characteristics can be found in Appendices A-1, A-2, and A-3.

FIELD METHODS FOR ANACAPA ISLAND

Parameters	Measurement
Abundance of breeding birds	1) Incubating birds 2) Pairs at nest site 3) Young at nest site 4) Nest count (post breeding survey)
Reproductive success	1) Chicks 9-14 weeks old 2) Brood size and age of young 3) Mortality of young (post breeding survey)
Phenology	1) Direct observation or dates based on age of young
Population age structure	1) Plumage a) Juvenile (brown head) b) Sub-adult (white on head, white belly) c) Adult (white head, dark belly) 2) Band sightings

Areas to be censused

At Anacapa, Brown Pelicans nest only on West Island. Nesting areas are almost always on the north slopes but they also occur on rare occasions on the southwest slopes, on the flat plateau/interior bluff areas and also in the canyons on the north side. Figure 1 shows pelican nesting sites used from 1969 through 1988. Colony sites are unpredictable from year to year; pelicans may breed in the same approximate area for several consecutive years, or they may completely shift to another part of the island. Several disjoined sites can also occur. Usually there is some overlap with the previous years' site. All known sites, therefore, should be checked at the beginning of the breeding season.

Methods

Potential Problems

A major problem in censusing Brown Pelicans on Anacapa Island is to have a clear view of the breeding birds, their nests and nest contents. Obstruction by vegetation or terrain, distance, fog, and sea conditions all limit the quality of observations. Using a boat is essential for finding colony locations, observing breeding progress, and censusing portions of the colony that can only be seen from the water. However, with the incumbent problems of motion and drift due to sea conditions, boat observations are often difficult and a good deal of practice is necessary before an observer gains confidence. Sea sickness can also be a problem for those who are susceptible.

Another major potential problem is colony disturbance when surveys are conducted on land. Disturbance at critical times in the breeding cycle can have severe detrimental effects on breeding success with the greatest impact occurring during the early stages of nesting. Brown Pelicans will easily abandon nests when disturbed, leaving unattended eggs and young chicks vulnerable to predation by gulls and ravens. Hyper- or hypothermia in young can also occur when nesting adults are away from the disturbed nest site for prolonged periods. Older, more mobile young may suffer injury or starvation if they are incapable of returning to the nest site. Chronic loss of food from regurgitation occurring as a fright response can also have an affect on the growth of young birds. Young pelicans of nearly fledging age but not yet fully developed may be forced to fly prematurely and can die from broken limbs or starvation. Even a one-time disturbance, if severe enough and at a critical time, can cause abandonment of a colony or sub-colony. In light of the potential consequences of disturbance, it is essential that monitoring personnel be extremely cautious and follow the outlined procedures for approaching observation points.

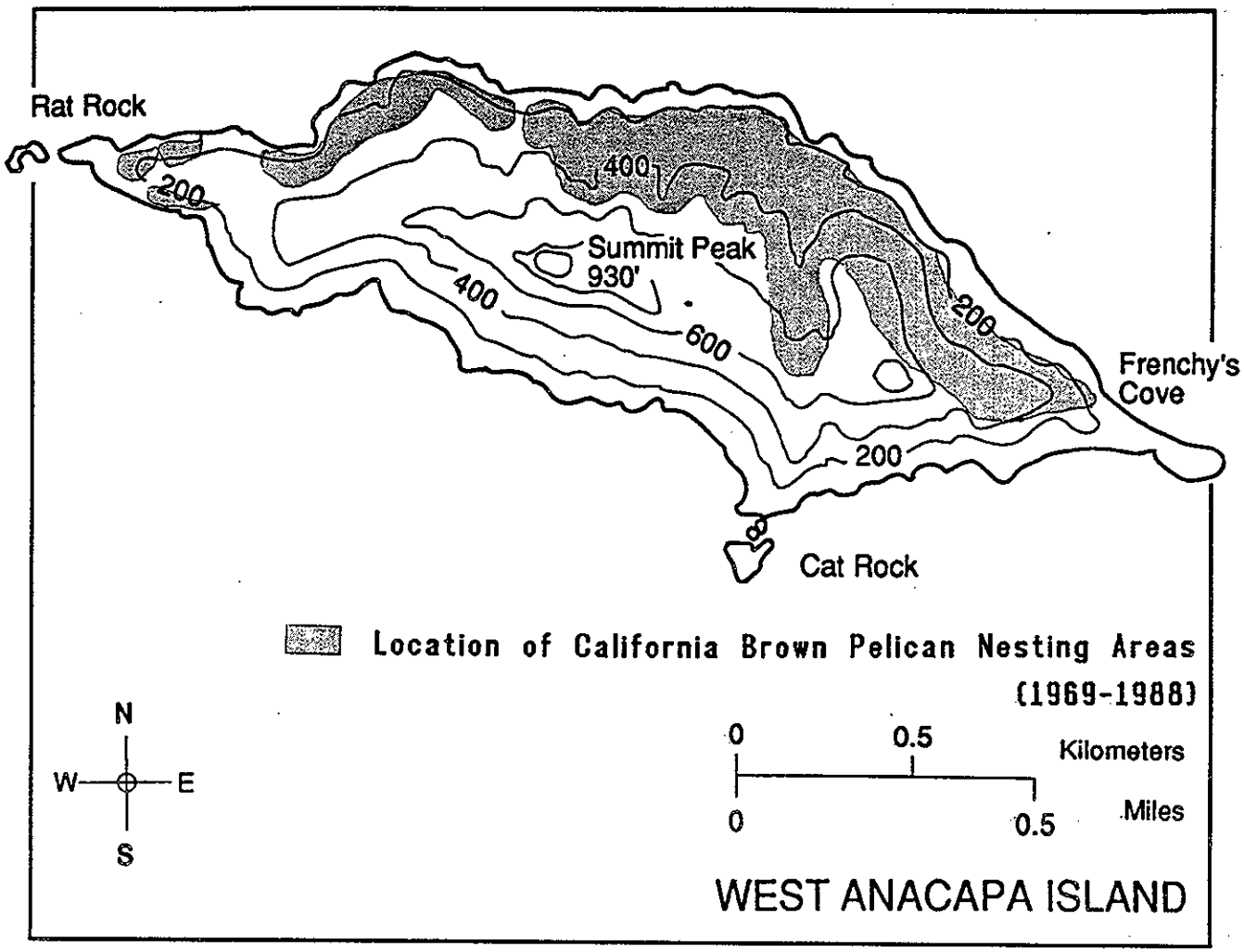


Figure 1. California Brown Pelican Nesting Sites - West Anacapa Island, 1969 - 1988.

Recommended Methods

Boat Surveys

Rather than working from a large vessel, it is recommended that observers work independently from a small boat, (e.g., 4 meter inflatable Avon with 15 hp outboard motor). This recommendation is made for the following reasons:

- rocking due to swells is greatly reduced,
- maneuverability and access to the shore are improved, and
- pressures of tight schedules and hurried surveys sometimes associated with crews on larger boats are avoided.

Also, when operating independently, monitoring personnel have greater flexibility in arranging censusing activities to take advantage of favorable weather and sea conditions. Observations/censuses are best made with 10x binoculars while drifting 25-150 m offshore of specific colony areas. Morning is generally the best time for observations by boat. At this time the water is usually calmest; also, as the day progresses, light refraction and glare intensify (especially along the north shore of West Anacapa) so that by mid-afternoon, long-distance viewing becomes impossible.

Land Surveys

Only a portion of the nesting colonies are visible from the water. Therefore, in addition to boat surveys, observations from points on land are necessary. During land censuses extreme caution must

be taken to avoid disturbing nesting birds. Observers should never get closer than 50 meters from the nearest nest; they should stay low and move slowly and quietly to minimize the effect of their presence. Sudden movement or noise can flush the birds from their nests, resulting in abandonment, egg and chick predation, or other consequences. Particular care should be taken to avoid sudden appearances over low ridges; when surprised, chicks may panic and jump off cliffs or be injured while fleeing. Young chicks driven long distances (or out of view) from their nests may not find their way back.

Access to observation points on West Anacapa Island is either from Rat Rock at the island's west end, or from Climb Spine (the ridge between Cherry Canyon and Cañada Por Nada; see Figure 3). From Rat Rock observers must go ashore (at a narrow surge channel at the west end of Sea Lion Cove) in an inflatable boat, then climb a steep rocky slope to reach the western terraces. If the colony site is in the Amphitheater area, one must climb Summit Peak (elevation 293 meters), which takes about 45 minutes, and proceed to Camel Peak (elevation 253 meters), which takes another 30 minutes. A small trail to Camel Peak from Rat Rock has been in use since 1978, but in early spring may be grown over with grasses in some places. After crossing the western terraces, the route continues along the southern ridge (Summit Ridge) over Summit Peak and along Saddle Ridge to Camel Peak.

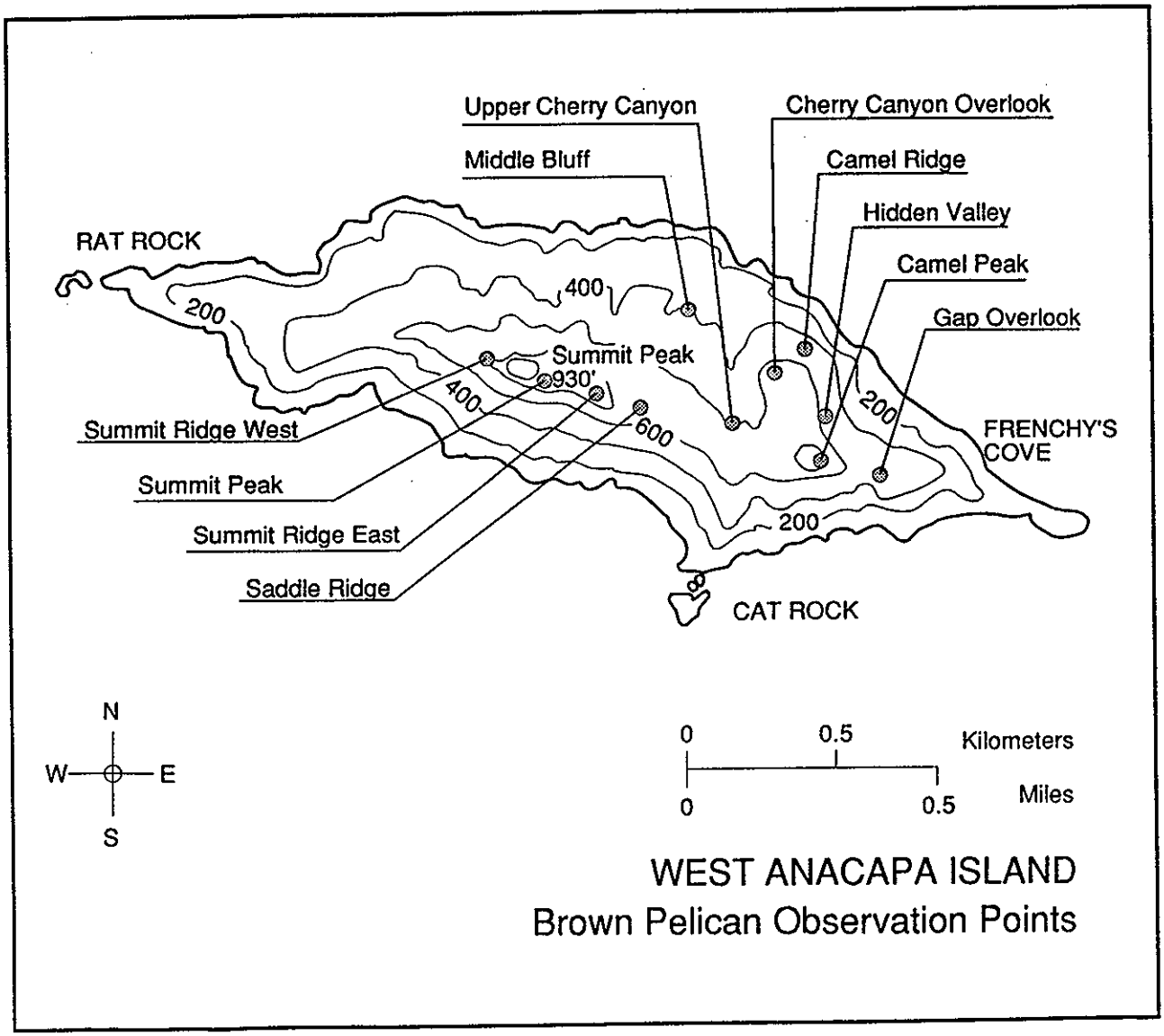


Figure 2. California Brown Pelican Observation Points - West Anacapa Island.

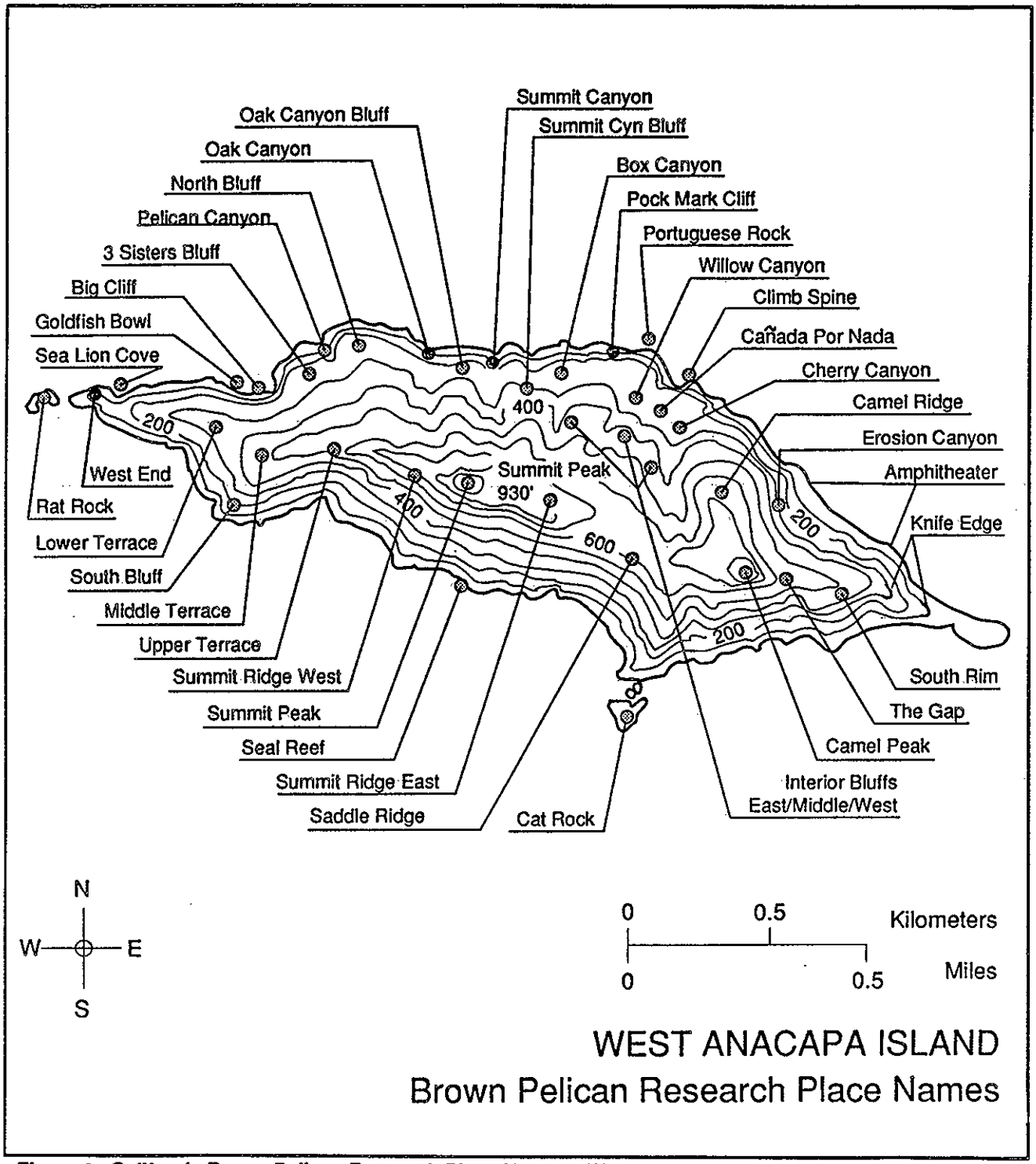


Figure 3. California Brown Pelican Research Place Names - West Anacapa Island

For quick access to the Interior Bluffs or the Amphitheater observation points, the Climb Spine route may be used. This access requires no pelicans to be nesting on East Interior Bluff nor in the lower part of Cherry Canyon. Observers must go ashore at the base of Climb Spine in a small inflatable boat. The approach is a steep, somewhat difficult ascent/descent plus traverse of a steep slope with loose terrain; **it should not be attempted by inexperienced climbers.** Travel time to top is about 15 minutes.

Specific observation points used to census pelicans on West Anacapa Island are shown in Figure 2. To view nesting on West Interior Bluff and Summit Canyon Bluff, observations should be made from East Summit Ridge and Saddle Ridge observation points. Observations of North Bluff and Oak Canyon Bluff nesting are best made from the West Summit Ridge site just below Summit Peak. Surveillance of Cherry Canyon and parts of East and Middle Interior Bluffs are made from Cherry Canyon Overlook and Upper Cherry Canyon observation point. Observations of the remaining portions of the Interior Bluff area are made from the Middle Bluff observation point. Colony sites in the Amphitheater area are best viewed from the four points on Camel Peak and its ridges. Use of a spotting scope, augmented by 10x binoculars, is essential from any of these observation points. If nesting sites are located at any other areas in Figure 3 (e.g., the north slopes not visible from land observation points, especially those close to the water), observations will probably have to be by boat in order to avoid unacceptable disturbance.

Locating Colonies

Since pelican nesting areas are impossible to predict each year, beginning in January and continuing until nesting has been ascertained, the north slope areas of West Anacapa Island should be surveyed at least monthly by boat. Areas used for nesting in prior years should be especially closely examined. Initially, pelican nesting activity can be difficult to discern because of thick vegetation, rough terrain, and lack of tell-tale signs, such as trampled vegetation and obviously well used nest sites. As the colony size increases, nesting areas become more conspicuous, with vegetation becoming less of a visual barrier as it is trampled and dries up in late spring. Also, the amount of "whitewash" increases at nest sites and roosts in the colony area, particularly once hatching has begun.

Abundance of Breeding Birds

- total nest count

A total nest count usually requires censusing from the water as well as from land points on the island since not all nests are visible from either water or land. The number of active nests is obtained by counting incubating or brooding birds on nests and pairs of birds with larger, visible chicks on nest sites. When only chicks are visible at the nest, the parents may be away foraging; these nests are censused by the presence of chicks alone. Nests within the colony that have been completed, but for some reason deserted, are counted as ABANDONED. Averages of active + abandoned nests are summed to obtain the total nest count for each census.

To aid censusing, natural boundaries such as ravines, vegetative patterns, rocks and other geological markings, and nest groupings can be used to define nesting sub-units within each colony. Each sub-unit should be identified by name or number and mapped for comparison with future or past counts of the same area. Censusing by sub-units greatly simplifies counting of large numbers of nests and aids comparisons of breeding events over time.

Reproductive Success

- sample chick count and brood size

Productivity is determined by estimating the number of young fledged per nesting attempt. Determining fledging success in a synchronous breeding effort is relatively easy; however, for an asynchronous breeding effort it is much more difficult. In a relatively synchronous effort the eventual number that fledge can be reasonably estimated by counting the number of chicks that reach at least 9 weeks of age (once a chick is about 9 weeks old, the probability of its fledging is high). Pelican nesting, however, is usually highly asynchronous and can extend over a nine month period (Gress and Anderson 1983).

If all or most nests are visible from a boat or island observation points, relatively accurate total chick counts are possible. However, it usually is not possible to see all nests and chicks without causing unacceptable disturbances. The colony should therefore be sampled by locating and mapping areas where a sub-colony or group of nests can be seen clearly and where data can be obtained without creating disturbance. Whenever possible, make a total chick count for each sub-colony area, but in areas where some nests and chicks are obscured, use sample counts of at least 30 nests representing the entire spectrum of colony growth. Survey each sample area monthly to determine brood size and age of chicks per active nest and note the number of abandoned nests. It is best to determine the specific weekly age of all chicks in the sample; Appendix A-1 gives the characteristics of chick ages by week.

The determination of chick ages requires field experience with pelicans. If one finds it impossible to resolve chick ages to within one week (using the criteria in Appendix A-1), then the broader catagories in Table 4 (page 14) may be substituted.

By following the chicks in each sample through the breeding season, an observer can estimate the number of young that fledge from each nesting group, as well as the number in each brood. Brood sizes are best determined at ages 3-6 weeks. After six weeks of age, chick often gather in mixed-brood groups (creches), making brood-size estimates difficult or impossible.

More than two counts per census will be required because not all young will be visible in any one count; chicks are very mobile and may be momentarily hidden by vegetation, nest structures or terrain. After several counts, the minimum number of young associated with each nest or area becomes more clearly defined, and a sample variance can be estimated. Productivity computations include incompletely-built and abandoned nests, as well as those nests which produce fledged young.

Chick Mortality

- post-season nest count

A complete colony census should be conducted at the end of the breeding season (after all or most of the young have fledged) to count chick carcasses and examine nests. This should be done by mid-September before the first winter rains. Nests of the year in each sub-colony or area are counted and marked with lead-free spray paint (red or blue is best) to avoid recounts. Prior years' nests are usually readily distinguished from nests of the current year: material from old nests will appear weatherworn and gray; bowl linings (grasses, seaweed and other plant material) of abandoned nests will appear fresh in the present year and will generally not be present in old nests; old nests will often be overgrown by vegetation (especially by wild cucumber and morning glory vines). Often, by close examination, traces of paint from previous years' surveys can be found on sticks in old nests. Although the current year's nests which produced young will be heavily trampled, they are generally recognizable by being filled and "cemented" over by fresh white guano. Guano in old nests will appear weathered, deteriorated and much grayer; much of the previous year's guano will have been washed away by winter rains. For mortality data, carcasses of chicks are located, counted, and marked with lead-free spray paint (to avoid double-counting); the approximate age at death and brood size (if it can be determined) are recorded. In most years, the majority of chick carcasses found are 2-4 weeks of age. Carcasses are usually desiccated and found intact in the colony, often in the nests from which they were hatched. However, many carcasses are also found scattered or buried; therefore, be sure to search under vegetation close to nests, and to sift through nest contents for the remains of small dead chicks which can be buried under debris, dirt or covered by the guano of surviving chicks of the brood. The number of carcasses counted obviously represents a minimum mortality figure. Several attempts to determine a "missing chick carcass factor" have given an average of about 10% carcasses missed.

Table 4. Pelican Chick Age Catagories.

Chicks will appear as small downy white to large grey/brown, according to the following broad categories:

CATEGORY		PELICAN CHICK AGING CHARACTERISTICS
I.	1-4 weeks	Most of the 1-2 week olds will be closely brooded and usually not visible; the 3-4 week olds will be downy white with no dark feathers showing.
II.	5-8 weeks	These are intermediate size chicks still characterized by white down but with varying degrees of dark feathers beginning to emerge on the back and wings Heads and necks of 7-8 week old chicks are light dusky brown
III.	9-14 weeks	Chicks have obvious wing feathers and their heads, necks, backs, and wings are mostly dusky brown, becoming darker with increasing age.

Phenology
The date when nesting begins is not predictable. Since 1969 onset of breeding has varied from mid-December to mid-May (Anderson and Gress 1983; Gress and Anderson 1983; Lewis and Gress, MS). Phenological dates (within a week or so) can be estimated from chick ages and the known incubation and fledging periods.

Age Structure
- **plumage**
When censusing breeding birds, the number of nest-associated (but not incubating) birds and those loafing on the periphery of the nesting area should also be counted. Although four age classes can be identified at this time of year, distinguishing between juveniles, sub-adults and adults is sufficient for monitoring purposes, and it is relatively easy to record age-ratios at the same time by using the following classifications (see Appendix A):

- Juveniles - brown heads/white bellies
- Sub-adults - adult-like white heads/white bellies
- Adults - white heads/dark bellies

When possible all of Anacapa Island should be circumnavigated by boat for a complete census of roosting pelicans. In the event that time considerations, weather or sea conditions prevent surveying all three islands, at the very minimum the north shore of West Anacapa should be surveyed.

Band Sightings
During censuses, examine exposed legs of pelicans for the presence of bands and color-markers. U.S. Fish and Wildlife Service metal bands have been placed on the legs of California Brown Pelican chicks in the Channel Islands and Mexico since 1971. Data from these bands have yielded valuable information on population age structure, movements, and recruitment.

When a band is sighted, record the leg which has the band; sometimes both legs have bands or one leg will have two bands. (All double-banded pelicans are from Anacapa Island.) Some of the double-banded birds will have two sizes of bands attached: a small band which is about 1/2 inch wide and a larger band which is about 1 inch wide. There are two kinds of small bands: "lock-on" (which has a flange that sticks out) and "butt-end" (two ends of the band meet flush). These are usually very difficult to discern at a distance, but with careful observation this can be done with a spotting scope up to about 30 m away. Whenever possible the type of small band should be identified. If the type of band cannot be readily identified, state as such in field notes, but do not guess. Record the size of the band on each leg for double-banded birds, or the sequence of bands if all are on one leg. In some years, colored plastic bands and streamers have also been placed on pelican legs in addition to the metal USFWS bands. Record accurately whether it is a band or streamer, its color, the leg or legs to which attached, and position relative to metal band (for example, "white band over lock-on metal on left leg and blue band on right leg"). Try to describe colors as accurately as possible (i.e., "grass" green, yellow-green, aquamarine, lavender, dark blue, etc.), and even provide a sample of that color if possible. Plastic streamers are usually attached to the USFWS band with a "jess knot" and were originally about six inches in length. However, many of these become worn down or torn and may be considerably shortened when sighted. All marked birds will have at least one metal USFWS band on one leg. At the end of the breeding season, band sighting data should be forwarded to:

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University of California
Davis, CA 95616.

Monitoring Schedule
Begin looking for pelican nesting activity between early January and early February. Monthly visits should be made thereafter until the last group of young are ready to fledge; the last regular trip for monitoring purposes is usually in late August. Another visit to examine nests and determine chick mortality may be done in September after the last young have fledged.

Time Required

The time required to measure each parameter is highly variable and depends on such factors as experience of observers, locations of sub-colonies, and weather and sea conditions. Assuming good weather, the surveys can be done in one day in the earliest stages of colony building, but can take at

least three to four days per month after the chicks begin hatching. The in-colony nest survey and carcass count at the end of the season will take two to three days.

Recording Data

A convenient way to record census data is to have an observer verbally give census data to another person who acts as the recorder. Binocular or spotting scope observations can thus proceed without interruption for note taking, and the risk of double-counting or omissions is minimized. Field forms are not useful for most of these surveys; such forms would necessarily be too complex to be of practical use if they included all possible situations encountered. If an observer must work alone, a small hand-held tape recorder is the best means of taking data; however, caution must be taken that the batteries are fresh and the recorder is functioning properly. Check the recorder often, otherwise data can be easily lost.

Nests are recorded as "occupied" (a nest covered by a bird incubating eggs or brooding small chicks so that contents can not be seen) or "abandoned" (a nest built but no adults or young present). At a distance an abandoned nest may be differentiated from a previous year's nest in that the bowl of an abandoned nest contains fresh grasses and other vegetation, whereas old nests appear gray and have no bowl-lining material. Often a bird may be roosting on an abandoned nest giving the appearance of an occupied nest; if the bird is a sub-adult, then it is probably roosting and should be counted as such unless chicks are observed. When recording data, setting up columns in a field notebook works well, where occupied nests, abandoned nests, and pelicans by age classes (adult, sub-adult and juvenile birds) may simply be recorded by hash marks in respective columns.

Once a sub-colony has reached its peak and no more nests are being built within the sub-unit, nest counts per se are no longer necessary; emphasis then shifts to the determination of fledging success. In sample areas, brood sizes and ages can be recorded as follows:

For brood sizes:

B/1, B/2, or B/3 = broods of 1, 2 or 3 chicks

With specific ages of chicks: (see Appendix A-1)

B/2-6 = brood of 2 chicks, 6 weeks old;
B/1-2 = brood of 1 chick, 2 weeks old, etc.

If age categories are used: (see Table 4, page 14)

B1-I = brood of one chick, 1-4 weeks old;
B3-II = brood of 3 chicks, 5-8 weeks old, etc.

The above abbreviations can be called out by the observer to the recorder.

When shoreline surveys of roosting pelicans are conducted, a convenient way of recording the information is by writing the data on maps coinciding with location of observation. Photocopies of topography maps of Anacapa Island (one for West Island and another for East and Middle islands), placed in a covered clipboard work well for this purpose. Pelican age-ratio data, including band sightings, can also be recorded on the maps and transferred to field notes later.

When censusing, always record basic environmental data (cloud cover, wind, temperature, visibility) and note observation points. Weather conditions should be updated throughout the day, especially taking note of sudden changes from earlier conditions. Field notes should also include overview comments on vegetation type and density within sub-colony areas, as well as ancillary observations of pelican nesting biology, courtship displays, numbers of red-pouched adults present, numbers of sub-adults breeding, and numbers of juveniles present.

Safety

If operating a boat independently, basic skills in boat operation, safety, knowledge of sea conditions, and local weather patterns are essential. Always have a Park Service radio which includes marine band frequencies, basic tools, emergency food, water, compass, warm clothing, essential spare engine parts, boat repair kit, anchor, oars, sufficient gasoline, and life preservers. Be particularly cognizant of sudden changes in weather and sea conditions. Also, have some type of sun screen (SF-15 or better) and hat.

Ocean swells are often large at Rat Rock, and going ashore can be hazardous. Deck or tennis shoes should be worn on boats and when disembarking from boat to island. Since such landings are likely to be wet, carry hiking boots and an extra pair of

socks in packs and change from boat shoes once on dry land. Gear that may be damaged by seawater should be placed in heavy-duty plastic bags or watertight vinyl bags which have been securely tied off.

If climbing on West Anacapa from Rat Rock to the observation points, the first slope ascended (West End) is steep and consists of loose rock and soil; do not trust any rock to be solid. Most people find this to be a difficult climb; because of loose rock and fatigue, the descent can be particularly treacherous. Also, Western Gulls nest on this slope and will harass intruders from mid-April through June (see Western Gull section); wearing a hat in gull breeding areas is recommended. If ascending Climb Spine, extreme caution must be used; the very steep, precipitous slope and loose terrain make this approach potentially dangerous. Wearing boots while hiking on West Anacapa is highly recommended. Cactus does not present a problem en route to the observation points and is only likely to be encountered on the south-facing canyon walls; nevertheless caution should be taken.

The trail over Summit Peak is steep in places and traverses areas of loose rock and soil, but in general should present no problem to someone in reasonably good physical condition. To minimize trampling of vegetation and possible erosion, use the existing trail and avoid making new ones. Because of heavy brush in places, wearing shorts is not recommended. Always bring adequate water and a lunch or trail food for a full day's hike.

Special Equipment

1. Inflatable boat with floorboards (e.g. 4 m Avon) with outboard engine (at least 15 hp), and necessary accessories:

   repair kit
   tool kit
   extra prop
   anchor
   extra line
   oars and safety equipment.

   Plastic sacks and vinyl watertight bag should be kept on board to protect gear from getting wet.

2. Inflatable dingy (3 m) with oars.

3. Spotting scope with zoom lens or one with variable eye pieces (recommendation: 20x wide angle, 25x and 40x) and tripod. Good quality 10x binoculars.

4. Rucksack for carrying supplies and equipment on land and on boat; an extra day pack is needed for items used only on the boat.

5. Ensolite foam pad is useful to sit on while observing colony.

6. Boat shoes; hiking boots.

7. Small, hand-held field tape recorder with extra batteries and tapes.

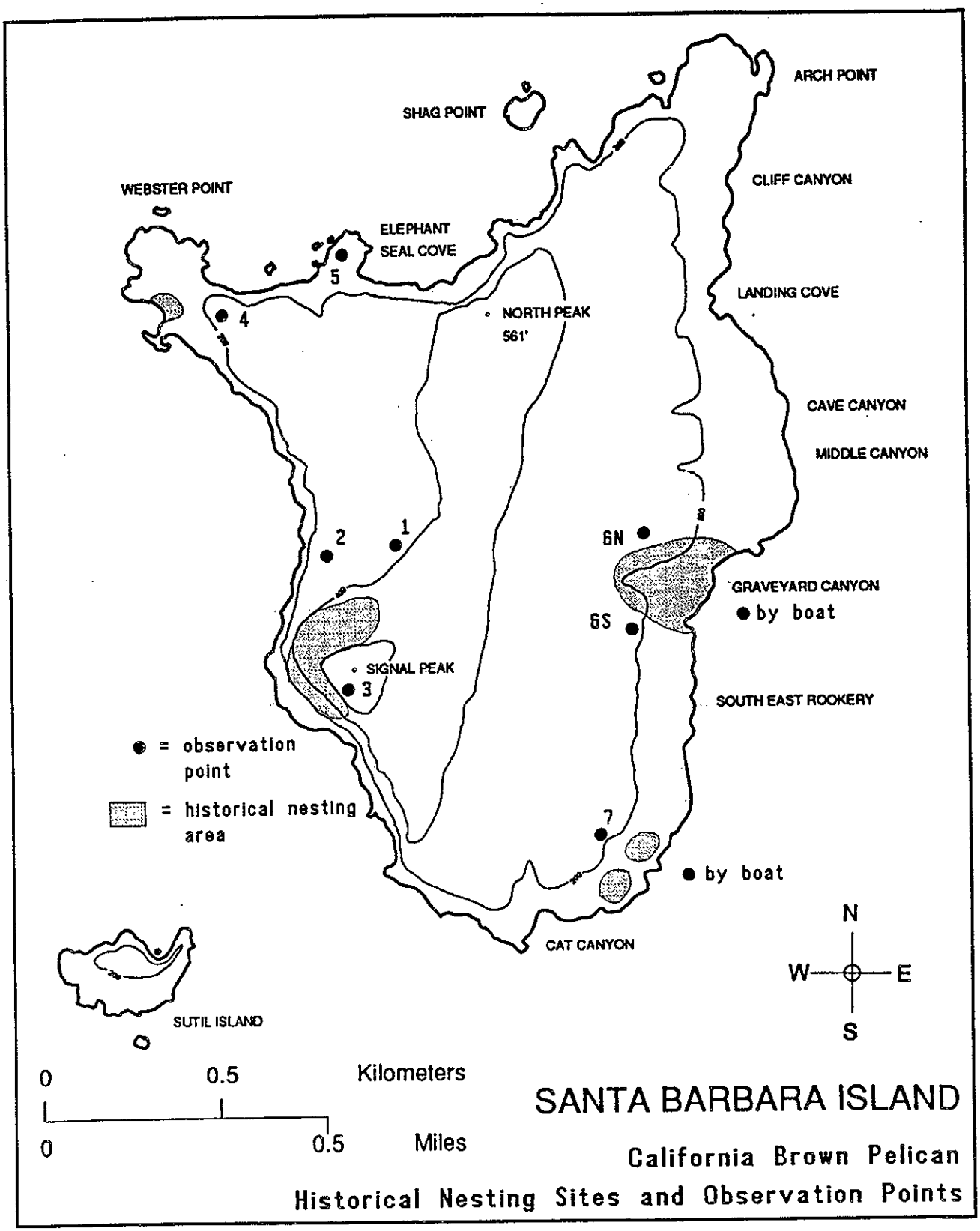


Figure 4. California Brown Pelican Nesting and Observation Sites - Santa Barbara Island.

FIELD METHODS FOR SANTA BARBARA ISLAND including Sutil Island

Parameters	Measurement
Abundance of breeding birds	1) Incubating birds 2) Pairs at nest site 3) Young at nest site 4) Nest count (post breeding survey)
Reproductive success	1) Chicks 9-14 weeks old 2) Brood size and age of young 3) Mortality of young (post breeding survey)
Phenology	1) Direct observation or dates based on age of young
Population age structure	1) Plumage a) Juvenile (brown head) b) Sub-adult (white on head, white belly) c) Adult (white head, dark belly) 2) Band sightings

Areas to be censused

Brown Pelicans occasionally nest on Santa Barbara and Sutil islands, but until recently nesting there has probably been rare. Since 1980, pelican nesting on Santa Barbara Island has occurred each year except 1981, 1982 and 1984. The nesting effort has ranged from 21 pairs (1983) to 1441 pairs (1986). Nesting sites include the north slopes and west cliffs (including lower terraces) of Signal Peak, Webster Point, Graveyard Canyon (including adjacent slopes and terraces) and the sea slopes between Cat Canyon and the south end of Southeast Rookery, in addition to the upper terrace of Sutil Island (Figure 4).

These areas (and other sites on the island perimeter) should be checked periodically beginning in late December for the presence of nesting pelicans. Make observations of the entire island, using the island trail system. Nesting on the southeast sea slopes and Signal Peak west cliffs will have to be observed from off-trail and/or by boat. Maintain a safe distance (100 m) from nesting activity, especially during early stages. Because portions of the trail may be near nesting sites, remain as inconspicuous as possible to avoid disturbance.

Methods

Follow the relevant procedures outlined for monitoring Brown Pelicans on Anacapa Island as they pertain to Santa Barbara Island.

Potential Problems

In addition to the problems of obscured viewing, boat motion, and disturbance as outlined for Anacapa Island, observers should be particularly mindful of off-trail dangers at Santa Barbara Island. Workers must always beware of steep, unstable slopes and encounters with cholla cactus. The west cliffs of Signal Peak are especially difficult to census because of these factors. (See "Safety" below.)

Recommended Methods

Boat Surveys

Most pelican nesting sites on Santa Barbara Island should be visible from land-based observation points. However, some portions of Sutil Island, and parts of Santa Barbara's deeper ravines (e.g. Graveyard Canyon) may only be viewed from seaward. If possible, make boat observations from a small inflatable craft dedicated to the task as described for Anacapa Island.

Land Surveys

The majority of pelican observations on Santa Barbara Island will usually be land-based. Specific observation points will depend on colony or sub-colony locations and their areal extent, which may change within a breeding season. Whenever possible make censuses from designated trails to avoid unnecessary off-trail damage.

Suggested observation points are shown in Figure 4 as described below:

For nesting on the broad north-facing slope of Signal Peak, observations usually can be made from Elephant Seal Cove Trail 50-100 m below (west of) the saddle (#1), or from further down the trail, above the north bend across West Terrace (#2).

Nesting on the west cliffs and terraces of Signal Peak can be viewed from several points above or partially down the cliff face (#3). Nesting on Webster Point may be seen either from Elephant Seal Cove Trail (#4, south side of point) or from Elephant Seal Point (#5, north side of point).

Graveyard Canyon poses visibility problems, but most nesting there can usually be censused from either of the canyon rims (#6, north or south), taking care to avoid disturbance of birds nesting on the adjacent terraces. Nesting on the southeast slopes of the island should be viewed from the bluff edge above (#7), or by boat.

Locating Colonies
Since pelican nesting sites are impossible to predict each year, beginning in January, all areas of Santa Barbara and Sutil islands must be checked for nesting activity. Monitoring efforts must in part depend upon input from resident rangers and other park personnel who are often the first to see early nesting activity and all such personnel should be instructed as to what nesting signs to look for. It is important that this information be channeled back to the monitoring staff and if such reports are vague or uncertain, an on-site visit should be scheduled for no later than mid-February each year.

Unlike West Anacapa Island, concealment of early nesting activities in thick vegetation is generally not a problem on Santa Barbara Island. However, nesting activity on the lower terraces of Signal Peak's west cliffs can be difficult to see; careful observations (perhaps by boat) may be necessary there, as well as in the lower reaches of Graveyard Canyon. Early-stage nesting on Sutil Island must also be independently assessed; this is most easily done by a pass-by of a NPS vessel making personnel changes on Santa Barbara Island.

Abundance of Breeding Birds
- total nest count
Determination of the number of pelicans nesting on Santa Barbara Island may require censusing from both land-based and on-water locations. As on Anacapa Island, a total nest count is made, consisting of the sum of averages of replicate counts of all active + abandoned nests within sub-colony areas. For details, see Anacapa Island.

Reproductive Success
- sample chick count and brood size

See Anacapa Island

Chick Mortality
- post season nest count

See Anacapa Island

Age Structure
- plumage

See Anacapa Island

Band Sightings

See Anacapa Island

Monitoring Schedule

See Anacapa Island

Time Required

The time required to measure each parameter is highly variable, depending on observer experience, locations of sub-colonies, and weather and sea conditions. Usually surveys of Santa Barbara Island pelican nesting can be accomplished in a few hours. In years of large nesting effort, allow a day or two for the post-season in-colony nest survey and carcass count.

Recording Data

See Anacapa Island

Safety

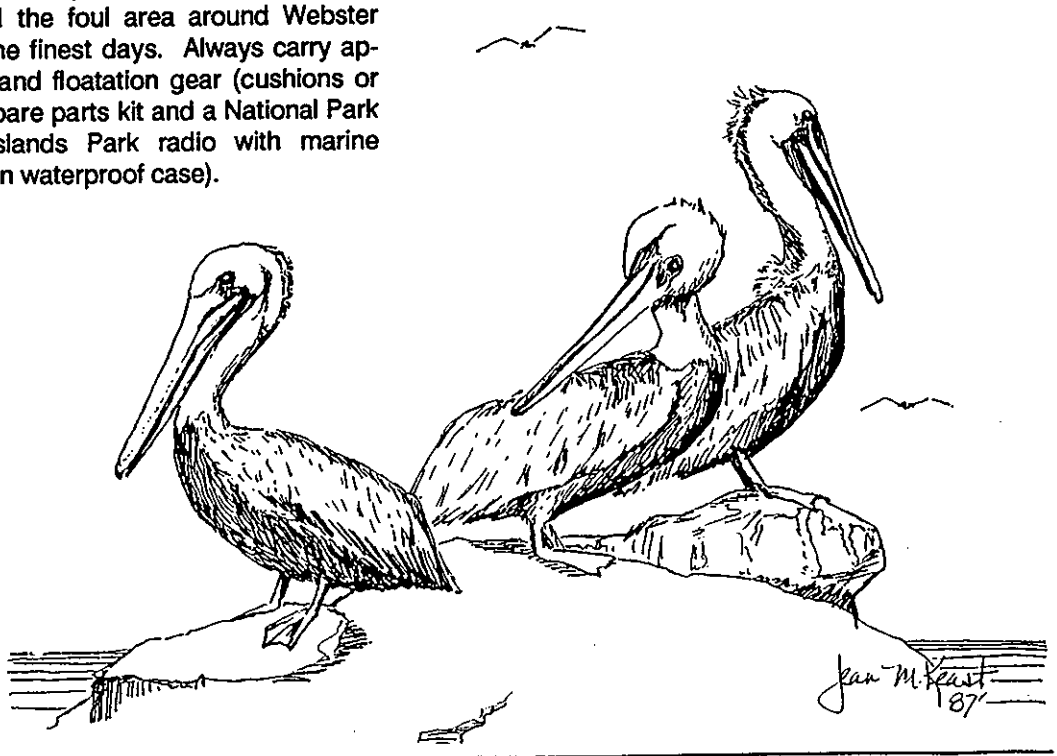
Boats -
In addition to the pertinent boating safety comments contained in the Anacapa Island section, the following considerations specific to Santa Barbara Island should be kept in mind. Boat observations may be from either the 6 m hard-bottom, 60 hp "attack" Avon or from the smaller 4 m, 15 hp inflatable. Either boat may be launched from the landing cove dock using the crane and appropriate harnesses. Workers must be trained and certified for crane and boat use. If the crane is not functioning, the smaller Avon can be launched with some difficulty from the adjacent rocky shoreline. This procedure requires two persons. During periods of south swells, the launch area can become quite treacherous. Always use caution and prudent judgement when making launch decisions. Winds and associated surface chop at Santa Barbara Island typically emanate from the west, increasing in intensity during the afternoon. Boat observations on the west side of Santa Barbara, (including Sutil Island) are thus often possible only during morning hours. When circumnavigating Santa Barbara and Sutil islands, exercise ordinary seamanship skills, maintain safe distances from exposed shorelines, offshore rocks and "boilers", and beware of entanglement in thick kelp. Southwest swells curling around the southeast corner of Santa Barbara and the southwest corner of Sutil islands can be particularly deceptive and dangerous. Avoid the foul area around Webster Point, except on the finest days. Always carry appropriate clothing and floatation gear (cushions or vests), tools and spare parts kit and a National Park Service/Channel Islands Park radio with marine band frequencies (in waterproof case).

On Land -
Land-based observations of pelicans on Santa Barbara Island often require dangerous off-trail hiking and rock-climbing which should be attempted only by competent climbers. Nesting and (especially) post-nesting censuses of pelicans on the west cliffs and terraces of Signal Peak must be done with extreme caution. Unstable rocks, gravel-covered rocky slopes and coastal cholla characterize this treacherous area. The steep cliffs of west and north Santa Barbara Islands are generally unstable. Do not venture close to cliff edges or overhangs. Cholla attacks are common during off-trail activities on Santa Barbara Island. Carry a comb or pocket-knife to remove offending joints without further injury.

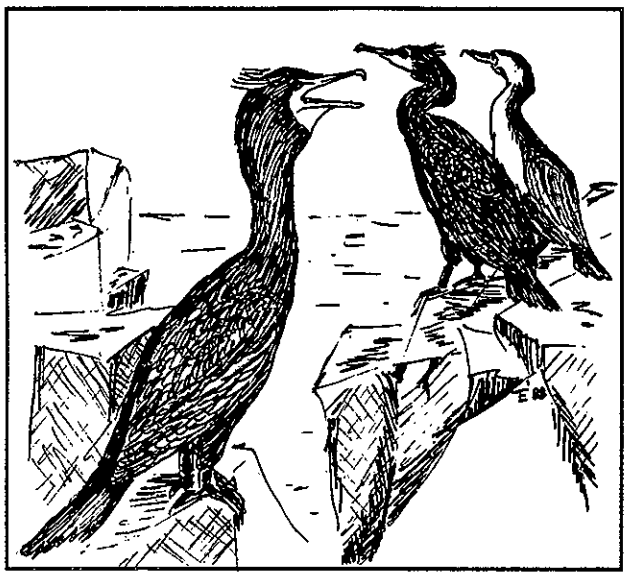
In addition to the above, always take appropriate precautions against sunburn (SF-15 or better sunscreen, plus protective clothing) and carry sufficient water to prevent dehydration.

Special Equipment

Special equipment needed for pelican monitoring on Santa Barbara Island is identical to gear requirements for Anacapa Island, except Item Number 2, (inflatable dinghy) is not necessary here.



DOUBLE-CRESTED CORMORANT



BREEDING BIOLOGY AND PLUMAGE

Double-crested Cormorants breed colonially in relatively small sub-colonies on West Anacapa, Santa Barbara, and Prince islands. They breed more or less synchronously usually beginning between late March and late April. Nests are large and built of sticks on bare rocks or ground; they resemble California Brown Pelican nests but are smaller. Like pelicans, Double-crested Cormorants may nest in the same areas utilized in the previous year or they may switch to a new area. Usually there is an overlap of nesting locations from one year to the next. Nest sites are generally located on exposed, inaccessible slopes or cliff ledges. On West Anacapa, Double-crested Cormorants may also nest within the Brown Pelican colony (F. Gress, unpub. data).

From two to seven eggs can be laid but three to four is the usual clutch size. The incubation period is 25-30 days; both parents participate. Newly-hatched young are altricial and are closely brooded for the first two weeks. The chicks begin wandering from the nest after about three to four weeks and occasionally form small groups (creches) at about four to five weeks. Young cormorants have flight capabilities at about five to six weeks, at which time chicks may fly a short distance but return to the nest site for feeding. Fledging occurs at about ten weeks, at which time chicks no longer return to the nest site to be fed and are fully independent.

During the breeding season, Double-crested Cormorants are easily distinguished from other cormorant species. They have bright orange gular pouches and (for a brief period during courtship) white plumes above the eyes; the plumes are lost soon after incubation begins. They frequently roost with Brandt's Cormorants and because of similarities, the two species can be confused. Brandt's Cormorants have an extensive buffy brown band of feathers posterior to the gular pouch. The lower mandible and gular pouch of the Double-crested Cormorants are bright orange or yellow-orange, whereas Brandt's Cormorants' pouches are vivid cobalt blue during the breeding season. Also, Double-crested Cormorants' plumage appears shinier and much more iridescent than the dull black plumage of Brandt's, particularly while breeding. The much smaller Pelagic Cormorant has a slim neck, smaller head and noticeably thinner bill than the other two species; during the breeding season, Pelagic Cormorants have a prominent white patch on each flank which is conspicuous in flight.

Newly-hatched Double-crested Cormorant chicks are purplish-black and naked. Black down appears in about five to six days and the chick is covered by down at two weeks. Juvenile plumage is complete after about eight weeks and is worn for approximately 12 to 13 months; their coloration is variable, ranging from light brown to brown-black during the first winter. Most are dull brown with paler brown necks and upper breasts and orange-yellow lower mandibles and gular pouches.

FIELD METHODS FOR ANACAPA ISLAND

Parameter	Measurement
Abundance of breeding birds	1) Nest structures
Reproductive success	1) Chicks on nest site 2) Brood Size
Phenology	1) Approximate dates based on age of chicks

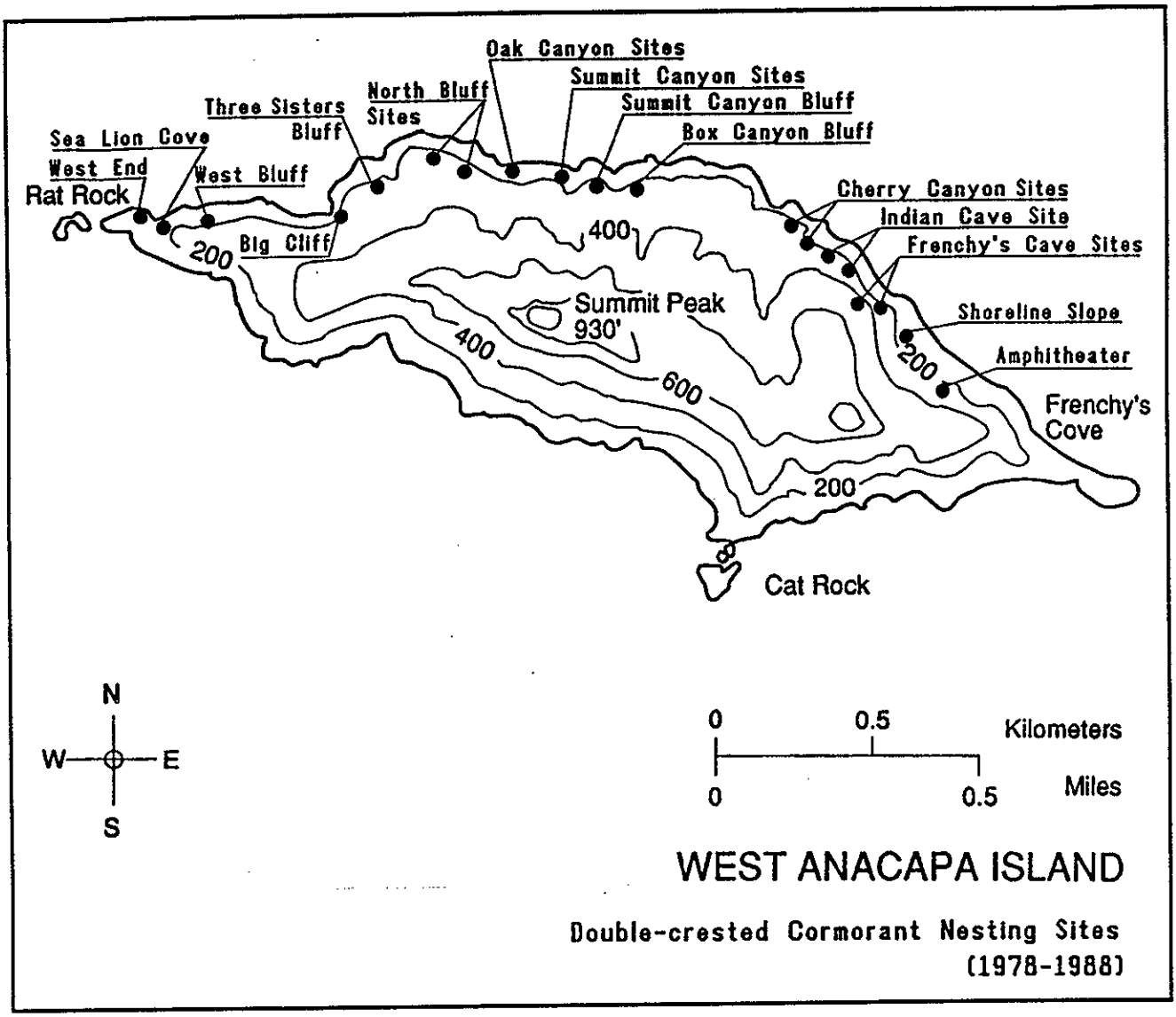


Figure 5. Double-crested Cormorant Nesting Sites - West Anacapa Island.

Areas to be censused

Since 1969 Double-crested Cormorants have nested only on Anacapa's West Island where several sub-colonies are usually established on the north slopes and bluff edges during each breeding season. Like Brown Pelicans, they may nest consistently year after year in the same general areas, but may also shift sites between years. Areas on West Anacapa where Double-crested Cormorants have nested from 1975 to 1988 are shown in Figure 5. Most nests can be viewed only by boat; counts of chicks in nests are obtained only for these closest to the water which can be seen clearly or for those few which can be seen from island observations points, as follows: (see Figure 5)

- "Big Cliff" can be viewed with a spotting scope from the bluff edge on the west side of the cove formed by Big Cliff.
- "Three Sisters Bluff" can be viewed from the same point as the Big Cliff group and also with binoculars from bluffs above the colony area if extreme caution is taken to remain inconspicuous.
- "West End" can be seen with binoculars when climbing from Rat Rock, being careful to stay on the south side of the ridge to remain out of view.

Methods

Potential Problems

Double-crested Cormorants on Anacapa Island are often difficult to observe. Like pelicans, a major problem with surveying cormorant nests and chicks is to obtain a clear view of the sub-colonies. The small size of the sub-colonies and the proximity of some sub-colonies to the water on exposed cliffs, however, in some ways eases Double-crested Cormorant censusing. But, while some nests are built on bare rock and ledges and are therefore quite visible, many are built among *Coreopsis* and other vegetation or are high up on bluffs and are therefore difficult to see. A cormorant's dark color makes them very difficult to see on nests, and a cormorant neck and head can be easily be taken for a dried-up *Coreopsis* from a distance. These problems are further compounded by the need to conduct surveys from a boat. Sea and weather conditions are the major limiting factors in obtaining data for this species.

Although three species of cormorants are known to nest on West Anacapa, identifying each (and their nests) is relatively easy. Brandt's Cormorants very rarely nest on Anacapa. Since 1969 they have nested in Sea Lion Cove on West Anacapa only in 1970, and on the north side of Rat Rock in 1982, (F. Gress, unpub. data). Pelagic Cormorants (q.v.) nest in small groups or singly on ledges or cliffs, or in caves, but not on bluffs or in vegetation on slopes as do Double-crested Cormorants. Both Brandt's and Pelagic Cormorants build small, rudimentary nests constructed largely of marine algae, in contrast to the much larger, bulkier stick nests that Double-crested Cormorants build; confusing a Double-crested Cormorant breeding effort with those of Brandt's or Pelagic Cormorants is therefore unlikely. Always look for nesting of all three cormorant species and be able to identify and separate them.

Cormorants are quite vulnerable to disturbance. They are extremely wary and take flight from their nests at the slightest provocation, whether approached too closely or startled by sudden noises. Like pelicans, their eggs and small young are very susceptible to gull-predation if the nest is left unprotected.

Recommended Methods

Boat Surveys - Locating Colonies

The north bluffs of West Anacapa must be carefully scrutinized for nesting activity. Look especially at those areas that have been colony sites in past years (see Figure 5). Since nest sites at the beginning of the breeding season are difficult to discern and because sub-colonies may only consist of a few nests, nesting areas can be easily overlooked. Look for cormorants in breeding plumage carrying nesting material in their bills flying to or from a bluff or circling and watch where these birds land; upon examining that particular area with binoculars, the colony can usually be found.

Abundance of Breeding Birds

- total nest count

Cormorant nests become more evident with the passage of time. Conducting surveys on relatively calm water is essential; the boat should be as close as possible to the shore while still being able to clearly see all the nests on the slopes above. If the sub-colony is large enough, separate it into segments; counting will be much easier this way. In time, the observer will be able to memorize the locality of individual nest sites. Take several counts until satisfied that all nests have been accounted for.

Reproductive Success

- sample chick count and brood size

The number of chicks and brood sizes can be estimated only in those sub-colonies closest to the water and those that can be viewed by a spotting scope from any available island observation points. The black color and small size of cormorant chicks make them very difficult to see; larger chicks are especially hard to differentiate from adults. Brood counts can only be made in the closest nests and requires considerable experience working with cormorants. Carefully examine nests for movements and look for yellow pouches. The best time to see the young is when they are being fed. Inexperienced workers will find brood counts to be a difficult if not impossible task; it is better to not attempt this than to press.

Monitoring Schedule

Begin surveying the north bluffs of West Anacapa for nesting activity by mid-April. Continue monthly surveys through August; these can be done at the same time pelicans are being censused by boat.

Time Required

The time required to census Double-crested Cormorants on West Anacapa Island is highly variable and depends on the number, size, and location of sub-colonies, as well as weather conditions. In optimal weather at the peak of breeding season, 75-100 nests spread among several sub-colonies will take at least four to five hours to survey, but this time can easily double in less favorable conditions. When determining age and size of broods, additional time will be required. Surveys should be done in the morning when sea conditions are usually best and sunlight refraction is minimal. Allow at least two mornings for each monthly survey.

Recording Data

Location of sub-colonies should be noted on a map of West Anacapa. In each sub-colony determine the number of nests built. Early in the season, all occupied nests will be covered by the adult bird. Look carefully for abandoned nests in the same area; this year's abandoned nest can be easily confused with a nest from a previous year. Recently abandoned nests still appear fresh, with fresh-looking nesting material and fresh guano around it; older nests look grayer and beaten down, with no fresh nesting material (see discussion of pelican nests on pages 8, 13-14). Record the number of nests in each sub-colony by distinguishing between occupied nests and abandoned nests. When chicks are 2-3 weeks of age, they can be seen in the nest from below; record the brood sizes and the number of chicks in the sample areas where counts can be obtained.

Special Equipment

See Brown Pelican section for equipment needed for boat and land-based surveys.

FIELD METHODS FOR SANTA BARBARA ISLAND

Parameter	Measurements
Abundance of breeding birds	1) Nest structures 2) Birds on nest 3) Chicks at nest site
Reproductive success	1) Large chicks in or near nest site

Areas to be Censused

In recent years (1985-1988) Double-crested Cormorants have occupied three distinct sub-colony areas on Santa Barbara and Sutil islands:

- Spire Point/Elephant Seal Cove
- Summit Peak West/A1 Cliffs; and
- Sutil Island north bluffs and cliffs.

These areas and their respective observation points are illustrated in Figure 6.

Methods

Potential Problems

On Santa Barbara Island, as on Anacapa, observers need to be very careful not to disturb nesting cormorants because of the susceptibility of eggs and small chicks to gull predation.

Double-crested Cormorants on Santa Barbara Island often shift nesting sites between the three subcolony areas each year. Observers should search the sub-colonies for new nesting areas and, if necessary, locate new observation points to best view nesting activities. This is particularly important in the West Cliffs area of Signal Peak where all nesting is not usually visible from the designated observation point on Figure 6. In this area some observations may have to be made from the Summit Peak bluffs which overlook areas of the subcolony south of the A1 cliff.

As Double-crested Cormorant chicks grow they become more difficult to distinguish from adult birds. Adults are darker with somewhat glossy plumage but can be easily confused with larger chicks whose softer, velvety appearance is conspicuous only in certain light. The orange throat pouches of adults are darker in color than the yellowish pouches of chicks. At too great a distance, in poor light, or from a boat on rough seas, large chicks and adult birds are nearly indistinguishable.

On Sutil Island, Double-crested and Brandt's Cormorants may easily be confused by inexperienced observers. However, Double-crested typically nest higher on the filoplumes above the eyes also readily distinguishes them from Brandt's.

Most of the designated observation points are at some distance from the subcolonies and require censusing through a spotting scope. Brood sizes may be difficult to determine, especially when chicks become old enough to wander form nest sites and form aggregations (creches). Brood sizes should be determined from a sample of clearly visible nests prior to creching.

Recommended Methods

The three subcolonies are best viewed from the observation points designated on Figure 6. At the Spire Point/Elephant Seal Cove cliff sites, set up observations on Elephant Seal Point a few meters below the crest. Observations of the Summit Peak A1 cliff site can be made from both the Elephant Seal Point trail where it skirts the west terrace cliffs (you must go off trail a few meters to near the cliff edge for a proper look - - be careful!) and from any convenient site atop Summit Peak's west perimeter, depending on where nesting occurs each year. Counts of the Sutil subcolony are conveniently made from the Summit Peak trail's northwest corner.

A few nests are usually accessible for close viewing of nest contents from above the Spire Point and Summit Peak Cliff sites. At Spire Point these nests are located in the ravine adjacent to the Elephant Seal Cove overlook and can be clearly seen from the ravine edge nest to the overlook. The Summit Peak Cliff nests are more variable in location and observers must therefore find new vantage points each year.

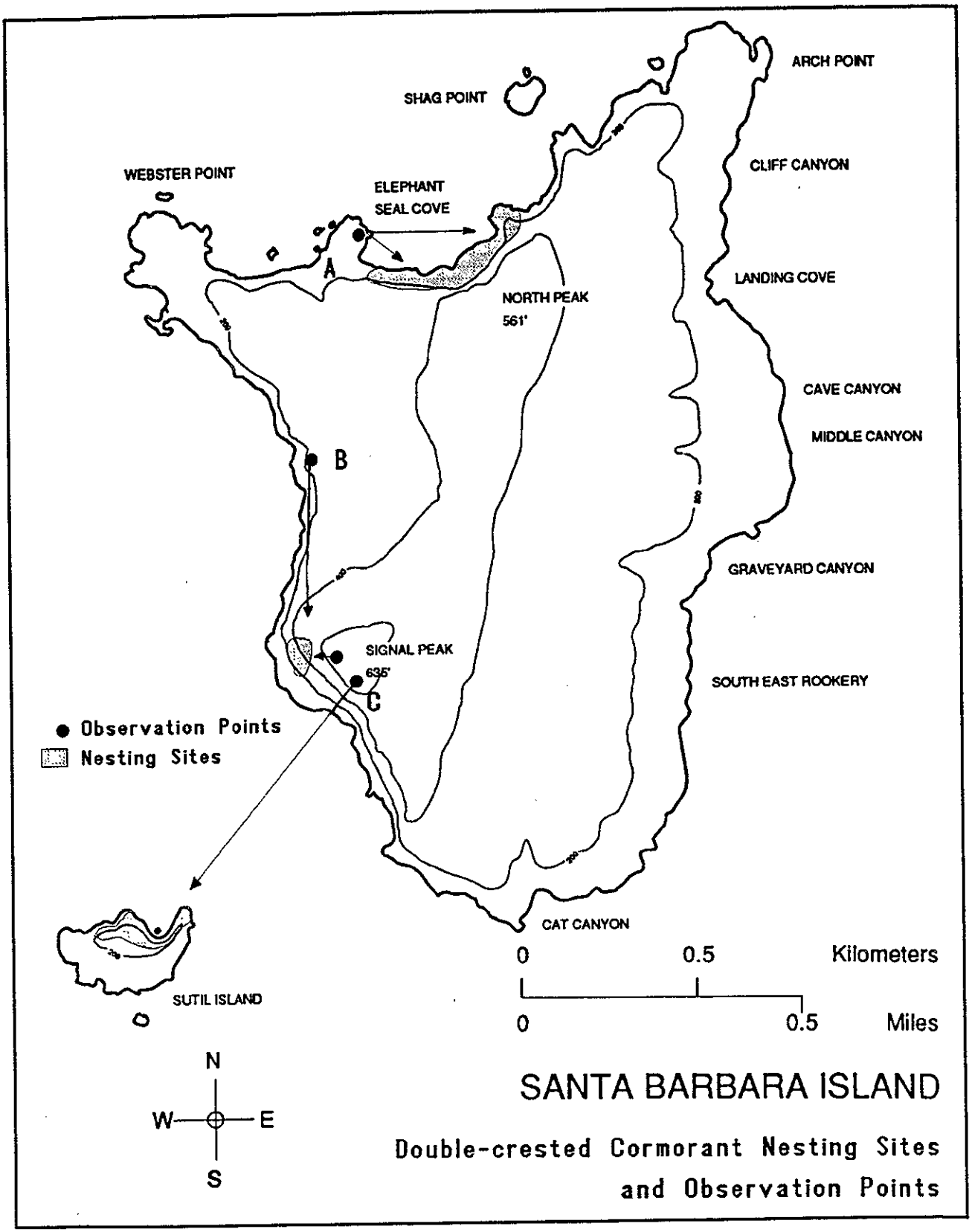


Figure 6. Double-crested Cormorant Nesting Sites - Santa Barbara Island.

Make preliminary assessments of nesting activities through 10x binoculars, noting rock and vegetation patterns to help subdivide and relocate areas to be censused. Make a sketch of each subcolony to further aid your censusing and to compare subsequent counts. For final counts use a spotting scope with a 20x eyepiece (occasionally a 40x eyepiece may help resolve difficult nests).

Make counts of active and abandoned nests (see Anacapa Island section for characteristics), incubating, brooding, and roosting adults, and of visible chicks. Whenever possible assign brood sizes to nests, but take data only on those that you are reasonably certain of. Make replicate counts to establish sample variance.

At the end of the season, it is useful to inspect closely any accessible nests for mortality and abandonment. Usually the only area where this is possible is on the lower ledges of the Summit Peak west cliffs. Be careful to avoid confusing Double-crested Cormorant nests with nests of Brown Pelicans which also may use this area for nesting (see Anacapa Island Brown Pelican section for nest descriptions). Mark each nest with lead-free spray paint (to avoid double-counting) as described for pelican nests on Anacapa Island and note any dead chicks. Use extreme caution when climbing here as the footing can be treacherous and the area is filled with cholla.

Monitoring Schedule
One or two counts per month of each subcolony should be made beginning in April and ending in July or August. The mortality count can be made anytime after all chicks have fledged and prior to the first winter rains.

Time Required

Counts of each subcolony will require up to an hour, depending on numbers and locations of nests, adults, and chicks. In addition, allow an hour commute (round-trip) to the Summit Peak area and an hour and a half for the Elephant Seal Point hike.

Recording Data

Use the sample nest-count abbreviations as described for pelicans on Anacapa Island. Since the ages of cormorant chicks are difficult to determine, simply list brood sizes for each nest with visible chicks (B2, B3, etc.); older chicks can be designated if desired. Sketch subcolony areas and note numbers of nests within sections of each subcolony.

Safety

Always use caution when working in the vicinity of cliff edges, and use extreme caution when making the post-season nest/mortality count of the Summit Peak west cliff lower ledges (this count should never be attempted solo). If you are not an experienced climber and comfortably familiar with the terrain and conditions on Santa Barbara Island, **DO NOT ATTEMPT THE POST-SEASON NEST/MORTALITY COUNT OF THIS AREA.**

Special Equipment

Santa Barbara and Prince Islands -

1. Spotting scope with 20x and 40x eyepieces; light-weight tripod. (Santa Barbara Is. only.)
2. Lead-free spray paint (red or blue is best) to mark nests and carcasses.
3. Hand-held clicker-counter for total nest count.

FIELD METHODS FOR PRINCE ISLAND

Parameter	Measurement
Abundance of breeding birds	1) Nest structures
Productivity	2) Sample brood counts

Areas to be Censused

Double-crested Cormorants traditionally nest on the rocky upper slopes of Prince Island, in and around the prickly pear cactus *Opuntia littoralis* on the southeast and southwest sides (Figure 7).

Methods

Potential Problems

To obtain nest and brood counts for Double-crested Cormorants from boat surveys can be extremely difficult and requires good light, calm seas, and experienced observers. Weather and sea conditions will often be problematic at Prince Island; conduct counts as early in the day as possible to take best advantage of the calmest winds and seas.

Brandt's Cormorants often co-mingle with Double-crested here, making it difficult to distinguish between the two species and to differentiate between adults and large chicks. Refer to the Anacapa Island and Santa Barbara Island sections for distinguishing characteristics of each.

Recommended Methods

Boat Surveys
Making counts from a boat is recommended as weather and sea conditions permit, during visits to Prince Island for Cassin's Auklet monitoring. Although these counts will often lack precision, by making several counts during the season, an index of nesting effort can be obtained. Scan the upper slopes of the traditional nesting areas (see Figure 7) with 10x binoculars and count visible adults, nests, and chicks. Use vegetation and rock patterns to subdivide the areas into distinguishable units. If broods are visible obtain a sample of brood sizes, but be careful to differentiate Brandt's from Double-crested Cormorants (see above). This census is usually quite difficult; get replicate counts from experienced observers if possible, with one person recording data. The waters here can be rough; using a sea-sick remedy is recommended for those prone to motion sickness.

Land Survey
Make a post-season nest/mortality count of accessible nests on the island. Distinguishing between old nests and nests of the current year requires experience (see Brown Pelican section for nest descriptions). As on the other islands, mark nests with lead-free spray paint to avoid double-counting and record any dead chicks found.

Monitoring Schedule -

Conduct boat censuses from March or April through July; this will be determined by Cassin's Auklet monitoring visits. The post-season nest/mortality count can be done in the fall (prior to the first winter rains) coincident with auklet nest box maintenance.

Time Required

The boat census work is usually done as part of a larger around-island census of all seabirds which takes about an hour. Allow three to four hours for the post-season nest/mortality count.

Recording Data

Record occupied and abandoned nests, adults, and chicks during the boat censuses as per pelican and cormorant observations on the other islands. For the post-season nest/mortality count, record total nests, old nests, and nests of the year (used and abandoned), and any chick carcasses found.

Safety

During boat censuses obtain a secure position on the deck or flying bridge to avoid slipping or falling overboard in the event of rough seas. On the post-season nest/mortality count use caution around cliff edges and beware of dislodging rocks on co-workers below. Perform this work only if you are experienced and comfortable with climbing conditions on Prince Island. You should be accompanied by one or more persons with climbing experience.

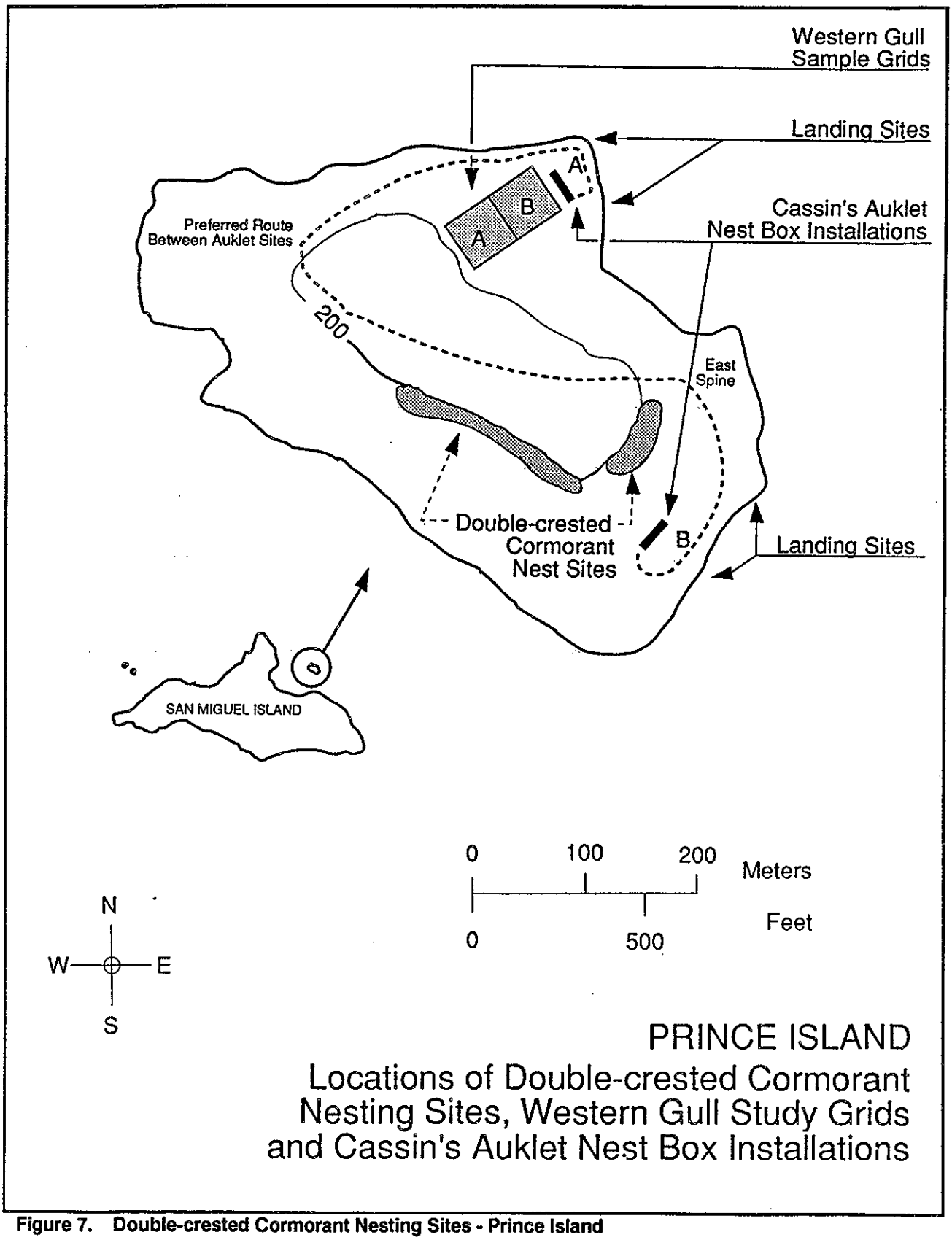
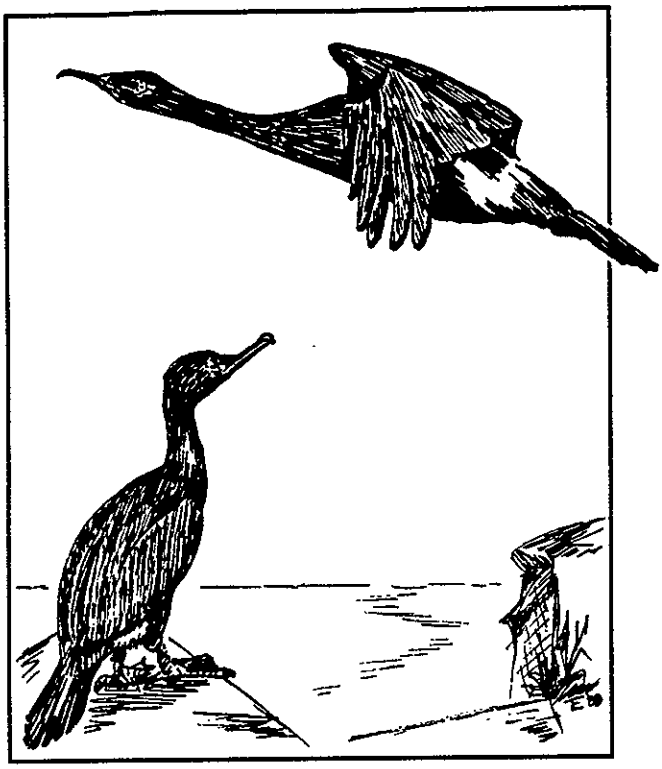


Figure 7. Double-crested Cormorant Nesting Sites - Prince Island

PELAGIC CORMORANT



BREEDING BIOLOGY AND PLUMAGE

Along the California coast, Pelagic Cormorants nest on steep rocky slopes and islets generally in small, scattered groups at relatively remote, precipitous sites. The Channel Islands are at the southern terminus of its range; about 85% of the California breeding population occurs north of Monterey Bay (Sowls et al. 1980). In the Channel Islands, San Miguel Island (including Prince Island and Castle Rock) harbors the most breeding pairs (approximately 300 pairs in 1977); lower numbers (less than 100 pairs) nest on Santa Rosa and Santa Cruz islands (Hunt et al. 1980). On Santa Barbara and Anacapa islands, nesting has been considerably more ephemeral and only a few nests have been reported.

Most of the breeding sites on the Channel Islands are impractical to monitor because of inaccessibility, low breeding numbers, or sporadic occupancy. However, in 1984 Pelagic Cormorants nested on East Anacapa Island in small (14 nests), but larger than usual numbers, and in 1985 nesting occurred on both east and west islands (27 nests total). In each succeeding year the number of nesting pairs has increased to the present (1988) total of 49 pairs. Because the breeding population has been consistent and increasing and since data on nesting effort, phenology, and productivity have been easy to obtain, Pelagic Cormorant nesting on Anacapa Island is being monitored.

Pelagic Cormorant nesting usually begins in mid- to late March and appears to be somewhat earlier than that of Double-crested Cormorants; the breeding effort appears to be fairly synchronous. Nests are inconspicuous mounds composed primarily of seaweed (although grasses and other plant material are often included) built on narrow white ledges of sea cliffs and caves. Three to seven pale blue, chalky eggs are laid (usually 3-5). The incubation period has been variously reported to be from 26 to 33 days (Palmer 1962); both parents incubate and care for the young. Although much less is known about the breeding biology of Pelagic Cormorants, the chronology of events leading to fledging is probably similar to that of Double-crested Cormorants as described previously.

Newly-hatched Pelagic Cormorant chicks are naked with blackish-gray skin and later acquire sooty down with distinctly pale thighs. Juvenile plumage is dark brown with paler brown underparts, but not as contrasting as in Brandt's and Double-crested Cormorant juveniles, both of which appear lighter in color (Palmer 1962). The neck and throat of juvenile Pelagic Cormorants show some violet gloss while greenish shows elsewhere; they are duller than the adults. Facial skin is ashy; bill and legs are brown.

Pelagic Cormorants are perhaps the most easily distinguished of the three cormorant species found in the Channel Islands, being noticeable smaller than the others. They have very slender necks ("pencil necks"), small heads, and thin bills. Breeding adults are glossy greenish black; they are much more iridescent than the other two species. Breeding adults have a conspicuous white oval patch on their flanks and scattered white filoplumes on the sides of the neck and shoulders. Adults also possess two short tufts on the crown and nape. The gular pouch and lower face of adults is an inconspicuous dull red. In flight Pelagic Cormorants appear more graceful than the other cormorant species and can be distinguished from the by their straighter profile with slender neck and smaller head outstretched. They also tend to be more shy and less gregarious.

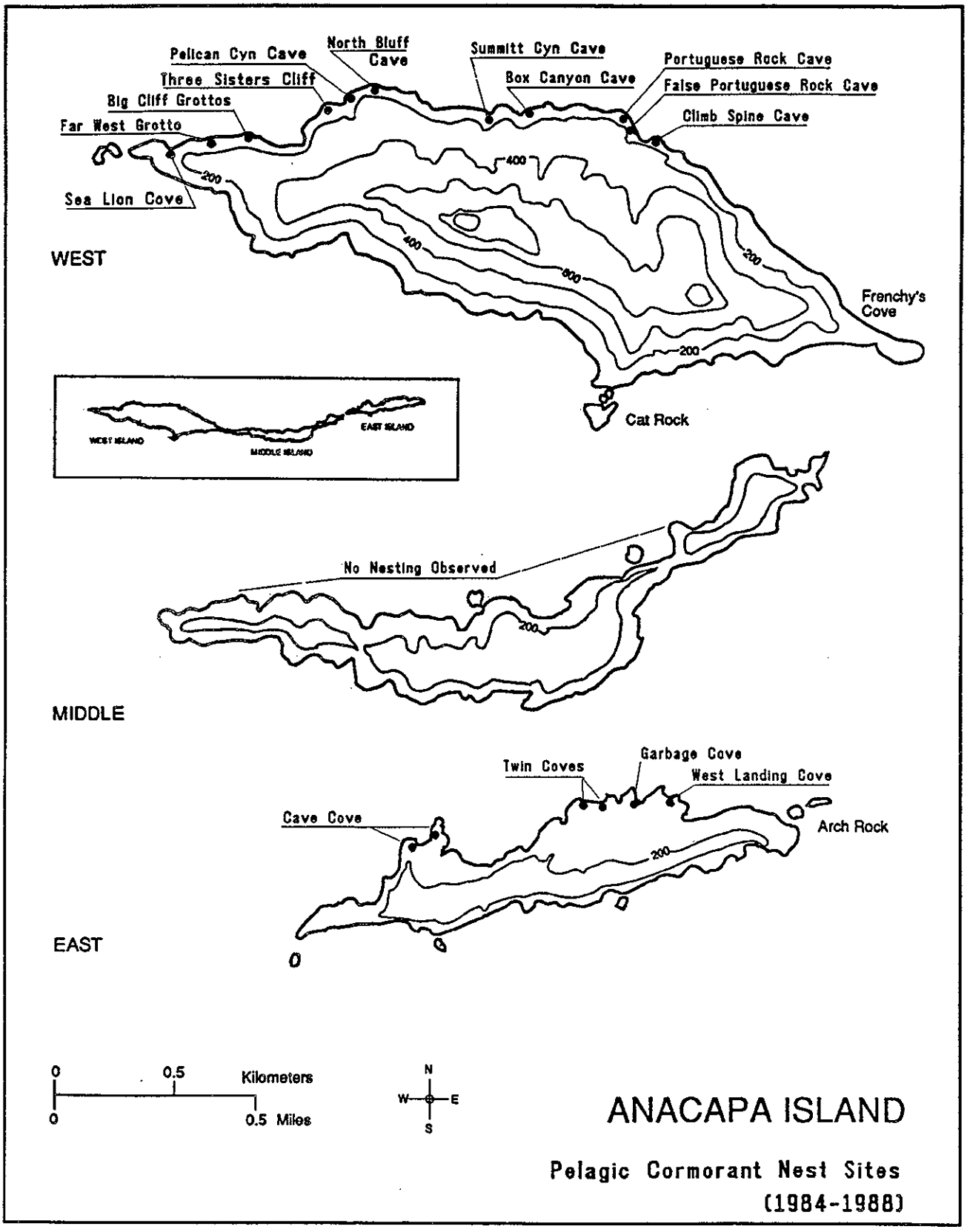


Figure 8. Pelagic Cormorant Nesting Sites - Anacapa Island

FIELD METHODS FOR ANACAPA ISLAND

Parameter	Measurement
Abundance of breeding birds	1) Nest structures
Reproductive success	1) Chicks on nest sites 2) Brood sizes
Phenology	1) Approximate dates based on age of chicks

Areas to be censused

Pelagic Cormorants have nested each year from 1984 to 1988 on the steep cliffs of Twin Coves on East Anacapa (see Figure 8). This area has the advantage of having land observation points (atop the cliffs overlooking the subcolony from each side of the cove), where most nests are clearly visible. Twin Coves should also be censused from a boat since all nests may not be seen from land. Recently, Pelagic Cormorants have also nested in West Landing Cove, Garbage Cove, Cave Cove, and Cathedral Cove on East Anacapa; each of these sites must be censused by boat. Since Pelagic Cormorant nesting seems to be expanding to new locations on Anacapa, and nesting sites may vary between years, all potential sites should be examined for nesting each year. Often, nest sites are on ledges inside sea caves and are not readily visible. Only one or two nests may be present at a particular site and can be easily overlooked.. It is necessary, therefore, to examine each cave and grotto along the north side of the island, as most are probably suitable for nesting. The caves usually have large openings with nesting ledges at least 5 to 15 m above the water surface. However, some nests are found inside relatively low "tunnel" caves which have multiple entrances and can be censused only in the calmest weather and sea conditions. Appropriate caves for nesting are limited in number but with experience become recognizable. Also, only certain cliff areas are suitable for nests; these have inaccessible sheer walls with rocky ledges or small holes used as nest sites. These too become recognizable with experience. As nests are built and eggs laid, nest sites become "whitewashed" and more readily apparent.

On West Ancapa Island, Pelagic Cormorant nests are scattered along the north shore in caves, grottos, and cliffs similar to those on East Anacapa, with only a few nests found in any one location (see Figure 8). Caves seem to be the preferred nesting sites on West Island; all potential sites must therefore be surveyed by boat. Although Pelagic Cormorants have not been discovered nesting on Middle Anacapa since the monitoring program began, a few nests have been reported historically (Hunt et al. 1980) and suitable nesting sites appear plentiful. Similarly, the few suitable nest sites on the south sides of the islands should be examined for nesting although none have been reported to date.

Methods

Potential Problems

As with Double-crested Cormorants, Pelagics are also susceptible to disturbance-related gull predation. However, since Pelagic Cormorants nest in smaller groups or solitarily and often in caves, they are somewhat less vulnerable. In particular, when viewing any nest or group of nests from land, observers must be cautions, keep low profiles, move slowly, and remain as inconspicuous as possible when moving to and from observation points and while observing. Because Pelagics tend to be close to the water surface (especially in caves), one must also use caution during boat observations to avoid close or rapid approaches. The sudden appearance of a boat accompanied by engine noise may cause a bird to flee its nest in a panic; in so doing it may accidentally kick eggs out of the nest or cause injury to small chicks. At cave entrances, boat observers should cut the engine and use oars if possible, approach slowly and noiselessly, and keep an appropriate distance from nest sites.

Viewing nest contents in cave sites is often difficult because of poor light or vantage points. Poor light in shadows of grottos and caves and rough sea conditions are the greatest deterrents to obtaining good chick counts.

Large chicks may be difficult to distinguish from adults, but are usually easier to tell apart than Double-crested because nests are more accessible for observation and the plumages are easier to differentiate; adults are quite dark and glossy, while the young are grayer and duller.

Recommended Methods

Locating Colonies

(See "Areas to be censused" above.)

Abundance of Breeding Birds

- total nest count

Pelagic Cormorant nests, although considerable smaller than Double-cresteds', are usually easier to see and therefore easier to census since they are relatively close to the water and are unobscured by vegetation. Furthermore, Pelagic Cormorants nests are solitary or in small groups, thus making censusing much more manageable. Locations of Pelagic Cormorant nests should be accurately described on a map with the corresponding number of nests at each locality.

Reproductive Success

- sample chick count and brood size

The total number of chicks and brood sizes can be estimated in nests which are closest to the water and easiest to see. In calm sea conditions most chicks can be seen in these nests. However, the best place to obtain brood size data is from land-based observation sites, such as of Twin Coves on East Anacapa, where observers can look down into nests, but these are rare. Often the older chicks will creche on intertidal rocks below the nesting area; these must be looked for as the season progresses.

Monitoring Schedule

Begin the censuses of known and potential nesting sites on the north shores of the islands in early to mid-April. Continue monthly surveys through August or until Pelagics have ended the breeding season. These surveys may be done while censusing roosting pelicans on all three islands and nesting Double-crested Cormorants or pelicans on West Anacapa. All potential nesting sites should be checked at least through mid-July. In this way, late nesters, possible re-nesters, and those missed on previous surveys can be found.

Time Required

Census times depend on the extent of the breeding effort, location of nests, and weather and sea conditions. In good weather with relatively smooth seas, censuses of known and potential sites will require at least three to four hours. If possible, two surveys should be taken on two different days during each survey period. The second survey will usually require less time since most nests will have been found in the prior survey. Make counts in the morning to take advantage of calm sea conditions and the best light; however, because of better access and visibility of Pelagic Cormorant nests, this is not as critical as it is with pelican and Double-crested Cormorant surveys.

Recording Data

Locations of nesting sites should be accurately described and noted on a map along with the number of nests and their status. During each census period, record the number of nests occupied by incubating or brooding birds (when contents are not visible), the number of empty or abandoned nests - they will be hard to sport, especially if there are no adjacent occupied nests. When chicks are visible, record the brood size in sample nests where contents can be seen. Also note any incidental information (e.g., nest-building, courtship, feeding behavior, etc.) that may be of interest.

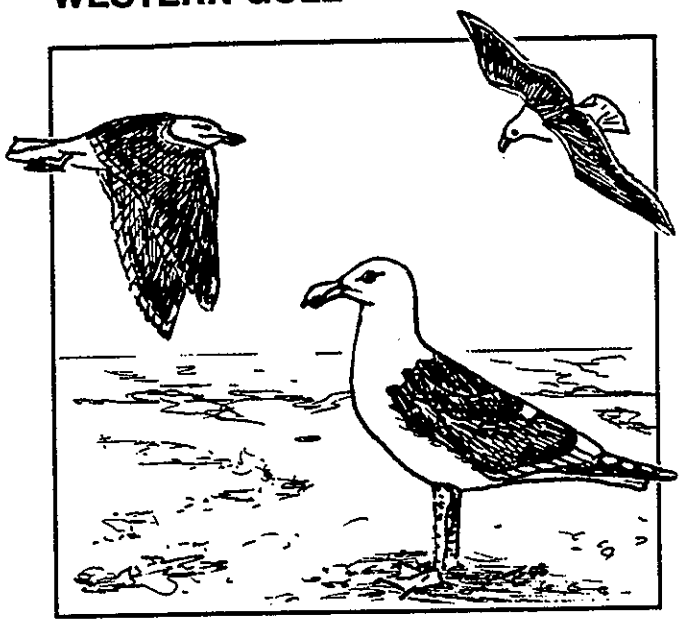
Safety

When making land-based observations (at Twin Coves) be careful around the cliff edge; it is a vertical drop of about 25 meters. Western Gulls will often dive-bomb anyone in this area, especially when their chicks are present. During boat surveys, always be aware of developing weather and sea conditions, and practice safe boat handling techniques. Be especially careful in tight caves where unexpected swells (such as wakes from passing freighters or tankers) can be amplified and potentially dangerous. See the Brown Pelican section for further boating safety considerations.

Special Equipment

1. 4-meter inflatable boat (Avon or equivalent) with 15 hp outboard.
2. 10x binoculars.
3. Spotting scope and tripod (for land-based observations).

WESTERN GULL



BREEDING BIOLOGY AND PLUMAGE

Gulls are easily observed surface nesters. The nests are usually associated with vegetation: iceplant and sea blight (*Suaeda*) on Santa Barbara Island, iceplant and shrubby annuals on Anacapa Island, and iceplant on Prince Island. Nests are simple and are made of stems, foliage and other plant parts when available; nest bowls are often grass-lined. Gulls may also occasionally lay eggs in scrapes on bare ground or sand or in crevices where no vegetation is present (Gull and Anacapa Islands).

Both parents incubate the eggs and seldom leave the nest unattended. The female usually lays three eggs - one egg every other day until a clutch is complete. Smaller clutches (one to two eggs) are not uncommon, but larger ("supernormal") clutches (four to six eggs) are rare - supernormal clutches are of particular interest, and should be reported whenever encountered. The average incubation time is 29 days with a range of 26-31 days on Santa Barbara Island. Chicks fledge between 41 and 43 days of age.

Gulls are territorial in the breeding colony and defend territory boundaries vigorously. Egg-laying begins from mid-to-late April and peaks the second week in May. Parents feed their chicks at the nest site by regurgitating partially-digested fish, squid, pelagic red crab (*Pleuroncodes*), shrimp, or human refuse. Adults are cautious during feedings and will sometimes delay feeding their young because low-flying gulls will often attempt to steal food as it is offered. Chicks fledge at the age of 7-8 weeks.

Western Gulls usually do not breed until their fourth or fifth year. Fledglings are adult size but are a dark brown color and have a black bill. Year-old birds are a deep brown, mottled with grayish-white and have dark bills. During the second and third years, there is an increase toward lighter plumage with large individual variation. Birds begin to acquire the characteristic adult white plumage with brown remaining in the wings and black at the end of the tail; the bill remains black at the tip. Full adult plumage is characterized by a completely grey mantle, white head, body and tail, and a yellow bill with a red spot on the lower mandible.

FIELD METHODS FOR SANTA BARBARA ISLAND

Parameter	Measurement
Abundance of breeding birds	1) Nest structures 2) Incubating birds
Reproductive success	1) Large chicks (over 500 grams)
Chick growth rate	1) Minimum of 3 weights per chick
Phenology	1) Clutch initiation; hatch initiation
Foods	1) Regurgitated samples and pellets
Age Structure	1) Band sightings

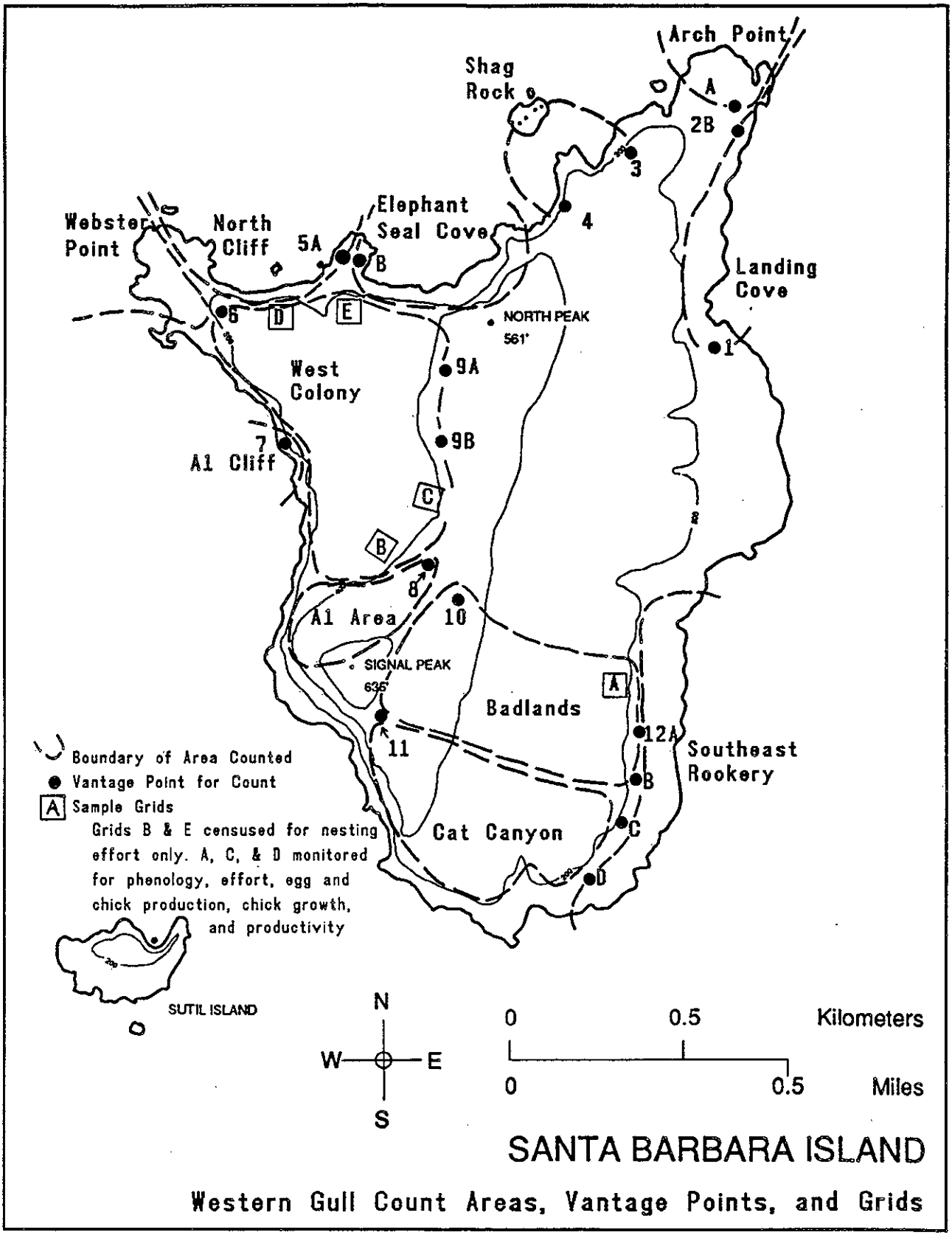


Figure 9. Western Gull Nesting - Santa Barbara Island

Areas to be censused

Five, 100 meter square grids have been used since 1975 to sample breeding pairs, fledglings, growth rate, phenology and foods (Figure 9). However, due to manpower considerations, banding, growth rates, mortality and reproductive success can probably only be accomplished in three (A, C, and D) of the five grids each year. Nesting effort (number of nests) and egg production should be measured each year in all grids. A total island nest count has been obtained annually since 1982 from vantage points around the island (Figure 9). Age structure has not been rigorously studied in the past, but age-ratio data can be developed at least on a limited basis.

Methods

Potential Problems

Monitoring Western Gull nesting on Santa Barbara Island presents problems of disturbance and vegetation damage. Although Western Gulls are far more resilient to human intrusion than are pelicans and cormorants, inopportune visits to gull study areas may cause serious impacts to them. While working in the gull study grids, be careful not to step on eggs or young chicks. Chicks sometimes do not hide in well-protected places, but are well-camouflaged and thus hard to see on the ground. In addition, it is safest to census during the early morning or late afternoon to avoid heat-stressing of eggs and chicks. Be cognizant of chick heat stress symptoms (continuous panting, drooping appearance, and torpor) and vacate grids accordingly. Young chicks (less than 2 weeks old) are especially at risk. Limit your time in each grid to two hours or less, except on cool foggy days. When working, move slowly and deliberately through the grids. This helps to maximize your awareness and minimize panic runs by older chicks. If a larger chick bolts beyond your immediate reach, crouch quietly until it settles; do not attempt a wild chase after it.

While in the grids (or whenever off-trail) avoid trampling native plant species. Step on grassy patches or ice plant if possible, and avoid sea blight since it is an important native plant providing cover for chicks. When searching individual bushes, take care to avoid breaking the brittle *Suaeda* branches. Although rare in the gull study grids, coastal cholla (*Opuntia prolifera*) can cause painful punctures, and should be avoided. Always carry a comb or pocket knife to extract embedded cholla joints.

Recommended Methods

Abundance of Breeding Birds

- total nest count

The purpose of the total nest count is to determine, as accurately as possible, the number of Western Gull pairs nesting on Santa Barbara Island each year.

For the most accurate data, counts of actual nests or incubating birds are best made from vantage points where observers are able to look straight down on a nesting area. Of the twelve designated census areas in Figure 9, eight allow sufficient visibility for obtaining accurate nest counts from single viewpoints. The remaining areas, where visibility is limited, require viewing from two or more sites. Table 5 shows viewpoint numbers to be used for censusing each area.

	AREA	VIEWPOINTS
I.	Landing Cove	1, 2B, raft
II.	Arch Point	2A
III.	Shag Rock	3, 4
IV.	Elephant Seal Cove	4, 5B
V.	North Cliff	5A
VI.	Webster Point	6
VII.	A1 Cliff	7
VIII.	A1 Area	8
IX.	West Colony	9A, B
X.	Badlands	10
XI.	Cat Canyon	11
XII.	SE Sea Lion Rookery	12A, B, C, D

Table 5. Reference numbers for Figure 9.

Counts should be obtained during the ten-day period following peak egg-laying, when chicks begin to hatch. Peak egg-laying occurs approximately two and one-half weeks after egg-laying begins. Counts should be done at the same time of day, either early morning or early evening when most gulls are in the colony, and should be spread over 2-3 days. Make separate counts of nests (as indicated by territorial or sitting birds) and individual birds, as both numbers are used to evaluate nesting effort. In large areas such as area IX (West Colony), it is easy

to lose track of sections previously counted; it is therefore useful to mentally partition the area using dark grassy sections, gullies, man-made trails, etc, being sure that all observers use the same boundary criteria.

Abundance of breeding birds
- sample nest count

The sample grid nests have been shown to be a reliable indicator of reproductive efforts for breeding pairs on the island as a whole (J. R. Sayce, unpub. data). To determine nesting effort and establish phenology, the grids must be systematically searched (2-3 times over a span of 1-2 weeks) in late April. Initially, observers need to be shown the 100 meter x 100 meter grid locations; even though the corners are marked with steel posts, these can be difficult to find in the dense vegetation. Corner stakes should be flagged with surveyor's tape each year. After a grid has been located, and observers are properly oriented, the nest search can be accomplished by one or more workers (three to four is best). Each grid is searched by 5-meter by 100-meter transects walked (remember, slowly and deliberately) parallel to a chosen grid boundary. When more than one observer is available, individuals should space themselves about 5 meters apart for optimum coverage. Thus observers work their way through each grid in a series of 5-meter by 100-meter increments, (think about it!). Use tent poles (two are kept on Santa Barbara for this purpose) to mark your incremental progress through the grid. Poles are placed at the ends of each transect and then moved alternately and sequentially, (think again!). The preferred start points and transect directions for each grid are as follows:

GRID	Start Corner	Transect Direction
A.	NW	S <---> N
B.	S	NE <---> SW
C.	SE	N <---> S
D.	NW	S <---> N
E.	SW	E <---> W

When a nest is located, hammer a prenumbered, wooden stake (kept on Santa Barbara Island) into the ground next to it; record the stake number and any nest contents (number of eggs and/or chicks) on your data sheet. Then map the approximate nest locations for each grid so they can be located more quickly on subsequent visits. Do not record nests which are empty (unless they previously contained eggs or chicks).

Once this routine becomes familiar and most nests have been staked, workers can be less rigidly systematic, and can use the map to locate staked nests while remaining alert for new or previously missed nests.

Phenology

The time required for an egg to hatch and a chick to fledge are well-documented for Western Gulls on Santa Barbara Island. By observing the timing of one event (e.g., egg-laying), hatching and fledging dates can be accurately predicted and censuses timed accordingly.

Reproductive success, chick growth rates, and food use

As gull chicks grow, they may wander from their nests, making looking for chicks a time-consuming effort. The procedures outlined below attempt to minimize the search effort and number of visits while still permitting collection of good data. A minimum of four grid visits per year is required to measure the above parameters.

Visit #1. Workers should find as many chicks as possible (at least 40 in all the grids combined), weigh them, band them, and collect any food samples. If chicks are not in the nest, check the vegetation and gullies in the nest vicinity, moving more or less in a circle away from the nest. Bushes are favorite hiding places for chicks, but any plant encountered on the run may be used for cover. When a chick is found, pick it up gently by its back and folded wings. When handled, chicks will often regurgitate food; if this occurs, identify the food item to the best of your ability, and weigh it. The chick should then be weighed to the nearest gram. Attach a U.S. Fish and Wildlife Service band to one of its legs and record the band number. For chicks weighing less than 100 g, use velcro bands or webbing tags (Alliston 1975, Willsteed and Fetterolf 1986). If age data are to be collected, also band the

chicks with appropriate plastic color bands and record the banding configuration. Replace chicks in a hiding place so that they do not run a long distance from the nest.

Visit #2. Ideally, in five days repeat the above procedure. Find as many of the previously banded chicks as possible and take weights and foods for those whose initial weight was 100 g or less. For others, simply note their presence with a minimum of handling to determine band numbers. Often, bands can be read without moving the bird itself by gently pulling its banded leg out from beneath it. If new chicks are encountered (not previously banded), band and weigh these.

Visits #3 and #4. Repeat the chick census twice more at five day intervals. Follow the same procedure as for Visit #2.

For useful growth data at least 3 weights per chick are required between hatching and 600 grams. For mortality calculations, all chicks reaching 500 grams in weight are counted as "fledged" because few chicks die once they attain this weight unless there is a serious heat wave (Salzman 1982). When dead banded chicks are found, record their band numbers and make total mortality calculations at season's end. A final census should be done at the end of the season to count carcasses and to pull nest stakes.

Age structure - band sightings

Useful information on the age structure of this population would require a long-term banding program in which fledged birds are banded with an incloy (non-aluminum) band as well as color bands coding for island and year class. In recent years, some birds have been individually color banded or banded for year class. By recording all color combinations seen while working in the colony and recovering dead birds, data on age structure can gradually be developed. At the end of each season send a record of all color-band sightings to:

Dr. George L. Hunt, Jr.
Depart. of Ecology and Evolutionary Biology
University of California, Irvine, CA 92717

Attempting to determine age-ratios from surveys of plumage characteristics is not practical because immature (non-breeding) birds seldom return to the colony.

Any person banding must either have a banding permit or must cooperate with a licensed bander; any banding activities should be coordinated with Dr. George L. Hunt, Jr.

Monitoring Schedule

Personnel should begin working in the grids no later than April 20 to record commencement of egg-laying. All grid nests will need to be checked every 5 days to determine time of peak egg-laying and/or when the first chicks appear. Enlist the cooperation of the island ranger to spot pipping eggs or newly-hatched chicks if you are unable to be present on the island during this time. It is important to time your visits to coincide with peak hatching to maximize the number of hatching weights (and subsequent weight of known-aged chicks) obtained. On Santa Barbara Island this usually occurs during late May or early June, about a week after the peak on Anacapa Island. The total nest count should be obtained during the ten-day period after peak laying or when chicks begin to hatch. The sample nest count may be obtained as a matter of course when chick counts are taken. Chick counts (including weights and food samples) should begin in mid-June and continue through early July, with four counts spaced five days to one week apart.

Time Required

The total nest count might be obtained in one day, but with foggy weather this may extend to 2 or 3 days. Be sure to count at the same time of day for each day censused.

For the sample grids, we recommend checking one to two grids per day as can be integrated with other monitoring. Grids D and E contain the largest number of nests, and since they are adjacent to each other and travel time to these grids is longest (about one hour round-trip from the campsite), these should be censused on the same day. Grids B and C are also adjacent to one another and can be censused together. Grid A (on the southeast side) can be checked after grids B and C since these last three grids typically have fewer nests and can be censused more quickly. Allow about two hours for each grid for each day censused. When banding chicks, visits may take up to 50% longer.

Recording Data

For data entry of nest contents use Appendix B-1, using the following abbreviations:

A	= Addled egg	D	= Dead chick
B	= Broken egg	P	= Pipped egg
C	= Clutch		

Data from work in the grids (nest count, chick count, phenology, foods, and growth rates), can be recorded on two data sheets Append. B-2 and B-3.

When weighing chicks, first record "chick + bag" weight then subtract the bag weight (tare) to obtain chick weight. For band sightings, be certain to specify left (L) or right (R) leg when recording color combinations. As described in the Brown Pelican section, only record bands that can be identified with certainty.

Safety

Parent gulls will vigorously defend their eggs and young by "dive-bombing" intruders, so it is advisable to wear something to protect your head when working in the grids (e.g., a hard hat). While gull aggression usually poses no real danger to workers, it can be unnerving and sometimes bloody painful. Hard hats enable workers to concentrate on what is happening on the ground rather than worrying about activity overhead. The tent poles (see Special Equipment, below) can also be effective protection from attacking gulls; carry it so that the pole top is above your head height.

Special Equipment

1. You will need about 200 small numbered wooden stakes to mark nests. Hammering stakes into the ground can be done with a hammer, a rock or by using another stake.

2. Two tent poles, sharp at one end for use as direction guides for initial nest location, and for protection from aggressive gulls.

3. Three Pesola scales (300g, 500g, and 1000g) for weighing chicks.

4. Nylon-mesh "Ditty bags" to weigh chicks.

5. Small sealing (Zip Lock) plastic bags for food samples.

6. U.S. Fish and Wildlife Service metal bands.

7. Pliers to attach metal bands.

8. Plastic color bands and information sheet with pre-arranged color combinations.

FIELD METHODS FOR ANACAPA ISLAND

Parameter	Measurement
Abundance of breeding birds	Nest structures
Reproductive success	Chicks - 500 grams
Chick growth rates	Minimum of 3 weights per chick
Foods	Regurgitated samples
Phenology	Clutch initiation, hatch initiation

Areas to be censused

Three 50 square meter grids were established in 1987 on East Anacapa Island (Figure 10). These grids replaced the originals which were established below the lighthouse in 1982. Grids A and B are adjoining, and located approximately 100 m west of the lighthouse. The boundary line between the two extends northward from the lighthouse "Warning" sign at the end of the public access trail. Grid C is on the north terrace, approximately 100 m west of Garbage Cove. Grid corners are marked with 1/2" reinforcing rods.

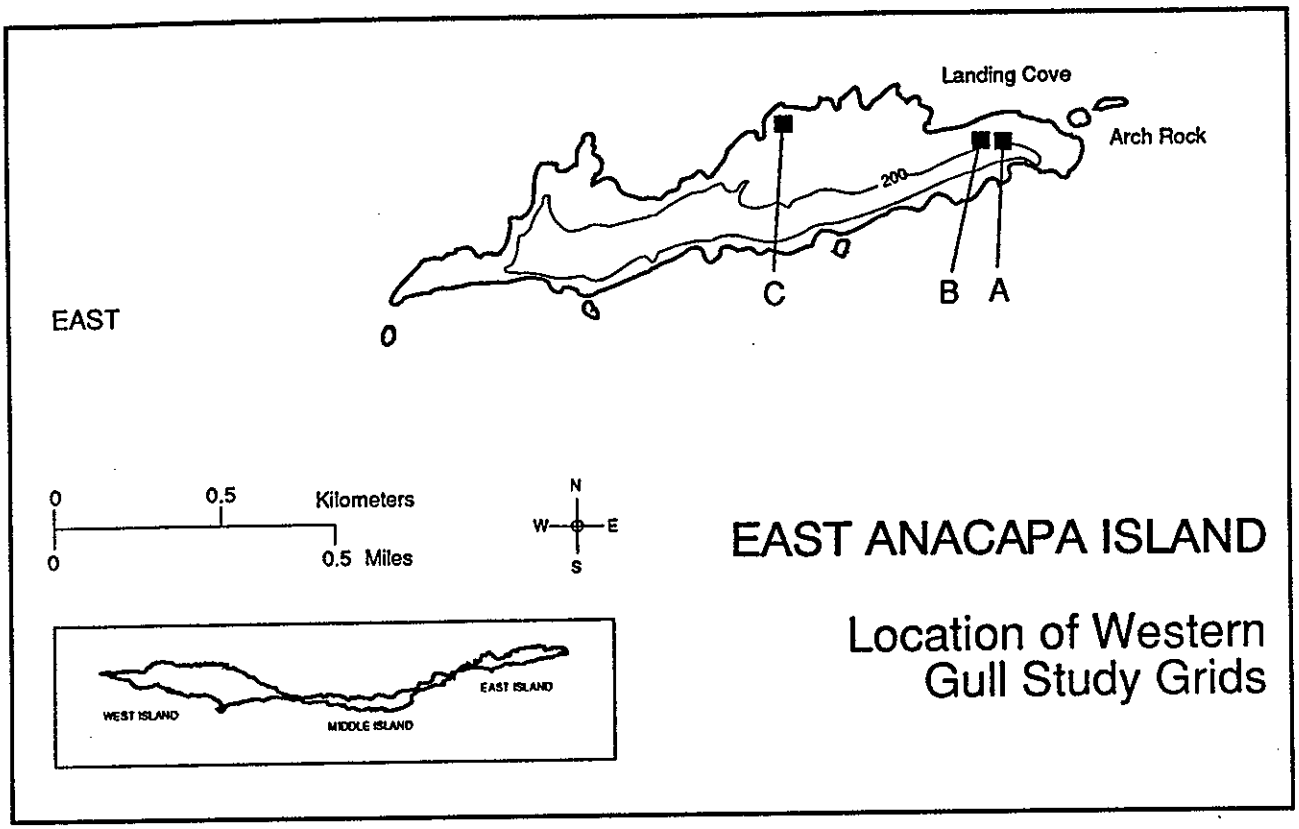


Figure 10. Western Gull Study Grids - East Anacapa Island

A total nest count of Anacapa Island is not conducted due to high variation in counts. Most of the gulls on Middle and West Anacapa can only be censused from the water and it is thus more difficult to identify and accurately census breeding pairs and incubating birds.

Methods

Potential Problems

The problems and methods outlined for monitoring Western Gull reproduction on Santa Barbara Island are applicable for censusing gulls on East Anacapa Island with the following changes: Western Gulls usually begin breeding about a week earlier on Anacapa compared to Santa Barbara Island (G. Hunt, unpub. data); therefore, observers should begin checking for the presence of nests in early April to obtain phenology (beginning of egg-laying). Once nests have been staked, check the grids weekly for additional nesting until the chick phase. Since the Anacapa grids are only one-quarter the size of the Santa Barbara grids, marking your progress with tent poles is probably not necessary as it is relatively easy to locate nests by walking straight lines through the grids at about 5 m intervals and drawing a map.

Begin weighing, banding and recovering food samples from chicks when they begin to hatch (usually mid- to late May). Continue until four chick censuses, spaced five days apart, are complete. Initial marking of the nests may take two or three days working only in early morning or late afternoon. Censusing each grid usually takes about two hours.

Western Gulls nest in higher densities in the Anacapa grids than on Santa Barbara Island. The Anacapa nesting areas are more open with fewer hiding spots for chicks, and the grids (especially grid C) are located near steep cliffs. Therefore, workers should use extreme caution to avoid flushing chicks over the cliff edges. Census the grids by working up from below (grids A and B) or from the cliff edge eastward (grid C). Be particularly cautious when working the western edge of grid C to avoid falling off the cliff.

FIELD METHODS FOR GULL ISLAND

Parameter	Measurement
Abundance of breeding birds	Nest structures Incubating/territorial birds Adults present

Area to be censused

Most of the gulls on this small islet build nests on the southeast side. All areas of the island visible from a boat are included in the sample.

Methods

Potential Problem

Since Brandt's Cormorants occupy nesting sites on much of the island, censuses must be conducted from a boat.

Recommended Methods

Counts should be made through binoculars, as the survey vessel slowly circumnavigates the island at a distance of 100 m or so offshore. Census visible nests (identifiable by the presence of sitting or territorial adults) and total adults present. The nest count will serve only as an index to nesting effort, as many nests are located atop the island, out of view. It is recommended that two to three people count nests, or that an individual take multiple counts.

Monitoring Schedule

One or two censuses per year are recommended, as weather and boat scheduling allow. These should be done between mid-May and mid-June when virtually all nests have been constructed and most eggs have been laid. Counts usually can be accomplished en route to or from Prince Island.

Time Required

The count takes about an hour.

Recording Data

Record nests and adults according to their location on the island (i.e., southeast cliff, north cliffs, etc.).

Safety

Beware of shallow rocks (boils) near the island, especially along the north side.

FIELD METHODS FOR PRINCE ISLAND

Parameter	Measurement
Abundance of breeding birds	Incubating birds
Phenology	Approximate clutch initiation and hatch initiation.

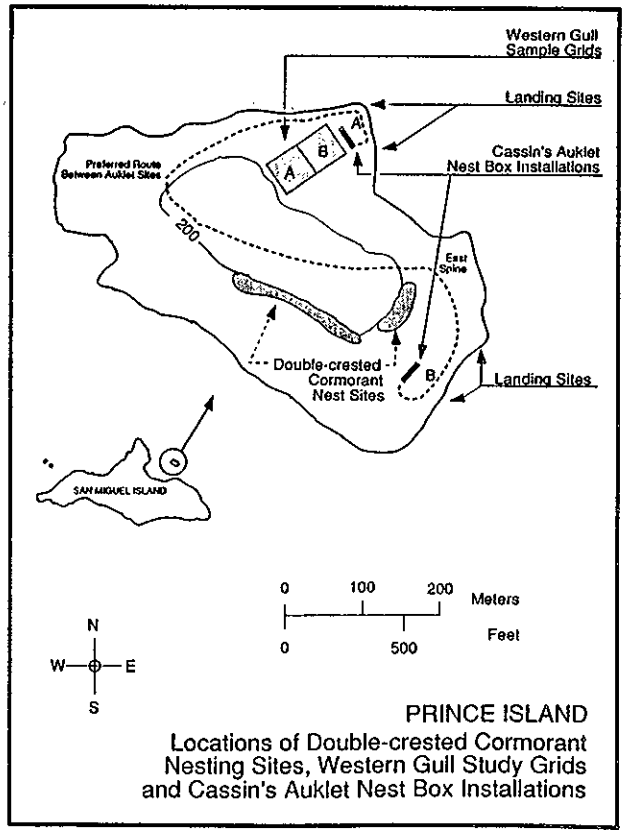


Figure 11. Western Gull Grid Sites - Prince Island

Areas to be censused

Two, 25 meter square grids are located on the northeast side of the island (Figure 11). These are adjoining, one above the other, and are marked by six white PVC flags each approximately .3 m high. The grids are positioned directly above the north Cassin's Auklet nest box installation.

Methods

Potential Problems

To avoid disturbing sensitive species such as Double-crested and Brandt's Cormorants, the grids may need to be censused from a boat. The major problem with boat surveys is decreased visibility.

Recommended Method

For the nest count it is recommended counting the number of incubating birds during the period just after peak egg-laying as described for Western Gulls on Santa Barbara Island (mid- to late May). The best vantage point on the island for censusing the grids is located about three-quarters of the way up the east spine of the island (Figure 11). The grids are best viewed through 10x binoculars from the rocky outcrop. If cormorant nesting precludes land-based observations, counts should be made from a boat below the grids.

Monitoring Schedule

Make counts of incubating birds in mid-to-late May.

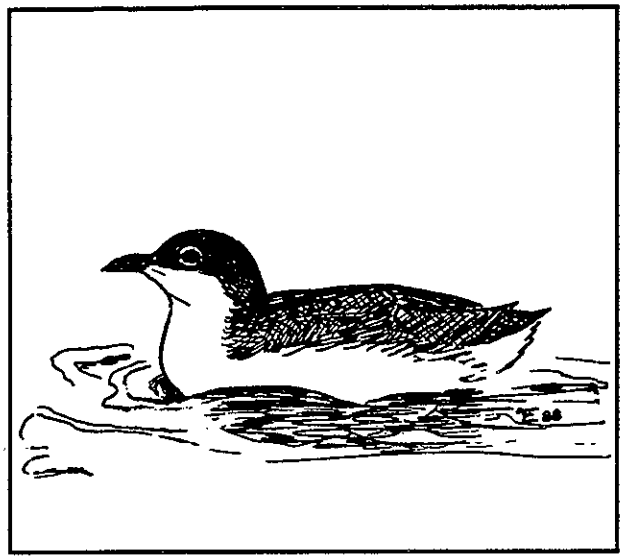
Time Required

Counts of each grid will take about ten minutes.

Special Equipment

No special equipment other than 10x binoculars is required for this survey.

XANTUS' MURRELET



Breeding Biology

Xantus' Murrelets nest mainly in natural rock crevices and small caves on cliff slopes as well as under bushes (*Eriophyllum*) spp. on Santa Barbara, Anacapa, Santa Cruz, and Prince islands. Typically, there is a small, round depression in the soil at the back of a burrow, where the female lays one or two eggs. Many of the burrows are angled so the eggs are not usually visible from the entrance.

Egg-laying usually begins between early and mid-March, although it may commence as late as mid-April. Both parents incubate the eggs, and often one adult will be present in the burrow during a census. An incubating bird will sometimes leave the burrow when disturbed, thereby exposing the egg(s) to increased probability of predation by mice. Incubation begins only after the second egg is laid (usually 8 or 9 days after the first), and lasts 24-39 days (on Santa Barbara Island), averaging about 34 days (Murray et al. 1983). Murrelet chicks go to sea 2-3 days after hatching, presumably accompanied by one or both parents.

FIELD METHODS FOR SANTA BARBARA ISLAND

Parameter	Measurement
Abundance of breeding birds	Number of burrows that receive eggs
Phenology	Clutch initiation Hatch initiation
Reproductive success	Number of chicks/hatched eggs

Areas to be censused

A sample of burrows where murrelets have nested since at least 1975 have been identified with numbered aluminum tags at both the Tent Slopes and Cat Canyon sites. There are 51 and 71 burrows, respectively, in these samples (see Appendices C-1 and C-2 for burrow locations). Attempting to precisely measure reproductive success may cause adults to desert the nest or generate inaccurate data since chicks remain on the island for only a few days after hatching. However, a reasonable index of productivity can be obtained if careful observations are made and care taken to avoid undue disturbance to the birds.

Methods

Potential Problems

Reaching the end of a burrow can be difficult. If the end is out of reach or cannot be seen, do not include it in the census.

Another potential problem is nest abandonment from monitoring interference. Workers should be as unobtrusive as possible; although touching birds is sometimes unavoidable during censuses, birds should never be removed from burrows or displaced in order to count eggs or chicks.

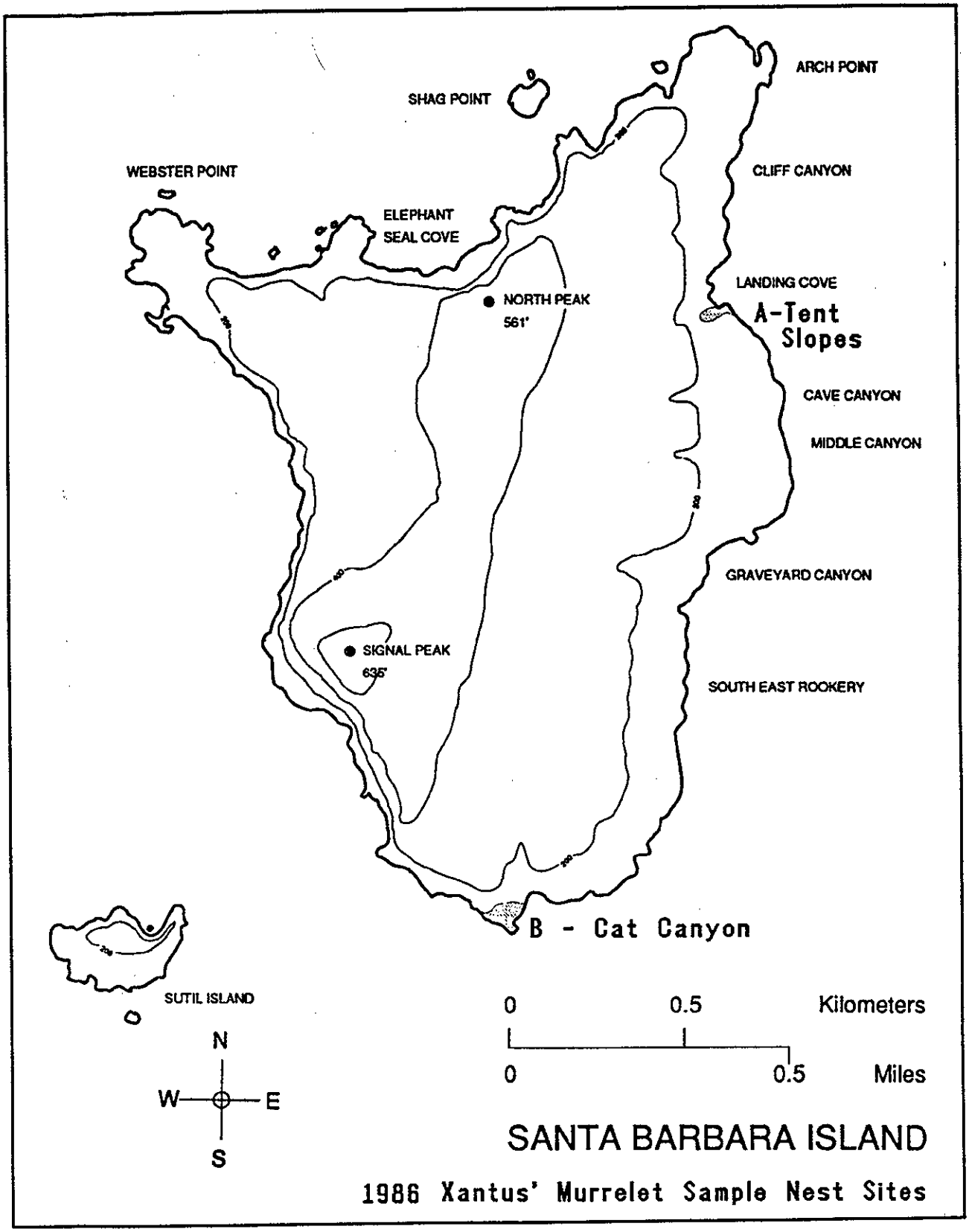


Figure 12. Xantus' Murrelet Sample Nest Sites - Santa Barbara Island

Recommended Methods

1. Look inside the entrance using a flashlight or reflected sunlight from an aluminum clipboard or mirror to illuminate the nest. This method is effective with short burrows or some rock crevices.

2. If the nest is not visible using method 1., then carefully insert a hand and follow the burrow contours until reaching the end of the burrow. This requires lying on the ground and can be difficult because burrows are often convoluted. Carefully feel around for eggs, incubating adults, or chicks.

3. If the nest is in a bush, check the entire bush, parting the branches carefully, while looking for incubating adults and/or eggs in the soil. Eggs, if present, are usually on relatively flat ground. Incubating birds can be remarkably difficult to see, even in relatively easily-checked bushes.

Eggs should not be removed from the nest unless they are broken, in which case they may be removed to identify the cause of death. Many murrelet eggs are preyed upon by mice; predation is evident by teeth marks on the edge of a broken eggshell. Old eggshell fragments from previous years are also likely to be found in burrows. These are dry, brittle and dirty, whereas new shells (from just-hatched or broken eggs) are often moist or have venation on internal membranes (see below). Workers are not likely to encounter other animals in murrelet burrows; mice are rarely found during a census because of their nocturnal habits.

Xantus' Murrelet monitoring is simple to learn, and requires relatively small investments of time and energy per each sampling. However the sampling frequency (weekly) requires nearly constant presence on the island, given the logistics of inter-island transportation. Therefore, it is very helpful to enlist the assistance of the island ranger to make nest checks during times when monitoring personnel are unable to be there. Also, efficiency is evident with teamwork; while one person checks a burrow, a second can find the next nest or record data.

Monitoring Schedule

For egg-laying dates, begin checking burrows in early March. Continue weekly census until all nests are inactive (normally by mid- to late June).

Time Required

Initially, it takes longer to check burrows, especially if workers are not accustomed to working on cliffs. The Tent Slopes site can be monitored relatively quickly; allow about 1-1/2 hours at first; this will decrease to about an hour with experience. For the Cat Canyon site allow 4-5 hours total, (it takes about one and a half hours to walk there and back). If time permits, it is recommended censusing these two sites on separate days, especially until the monitors become confident with the work. However, checking one site in the morning and the other in the afternoon of the same day is not too difficult.

Recording Data

When eggs, egg fragments, chicks, or adults are found, record the information next to the appropriate burrow number on the data sheet before going to the next burrow (see Appendix B-1, Seabird Nest Contents data sheet). The following abbreviations have been used:

E = egg
BE = broken egg (if egg is cracked open or if fresh eggshell fragments are present)
HE = hatched egg
B = brooding adult
C = chicks(s)

If an adult is present it is difficult to tell how many eggs or chicks it is incubating or brooding without removing the bird. Do not remove the bird; simply note "B"" on the data sheet.

Hatched eggs can be difficult for inexperienced observers to distinguish from broken (mouse-eaten) eggs. Broken eggs have a shiny, adherent membrane on the inner shell surface and are often tarnished with yolk blotches or clumps of dirt. Hatched egg remains lack the shiny adherent membrane (the membrane will be loosely attached, and dull) and do not have incipient yolk remains or tooth marks. Always carefully examine egg shell fragments for color-matching. Mismatched base-colors and flecking suggest the presence of more than one original egg. Identification of these is critical to any estimates of productivity.

Safety

The cliffs where murrelets nest are quite steep, gravelly, and dotted with cholla (*Opuntia*) "jumping cactus". The way to avoid accidents is to be very careful and use common sense. The following is recommended:

1. Avoid working alone until familiar and comfortable with climbing on the steep terrain in the study plot areas.

2. Wear boots with good traction and leather uppers to prevent slipping and to minimize cholla effects (see below).

3. Avoid cholla. A small pocket comb can remove cholla spines from boots. Be careful when lying down to check burrows; it is difficult and painful to remove cholla from skin.

4. Use a zig-zag path when censusing, this is safer than a straight up or down route.

5. Always take weather conditions into account before going to cliffs. To minimize sun glare, overcast days are best; otherwise censuses should be done in the morning or afternoon. Try to avoid working in strong winds.

6. Be careful: keep eyes on the ground when walking and take plenty of time.

Special Equipment

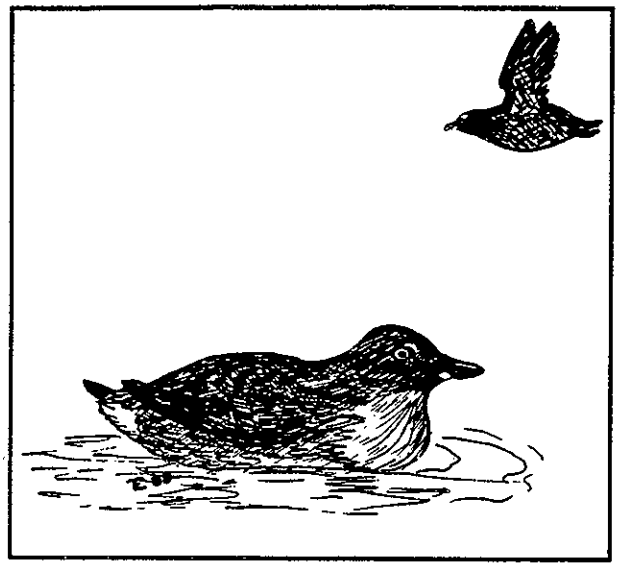
1. Flashlight

2. Small pocket mirror

3. Small pocket comb

4. Aluminum clipboard

CASSIN'S AUKLET



Breeding Biology

This diving species excavates burrows in loose topsoil or nests in rock crevices on Santa Barbara and Prince islands. In many areas on Prince Island burrows are closely packed and honeycomb the available topsoil; this high-density nesting typically undermines the soil structure and increases the likelihood of burrow collapse and soil erosion. Auklets excavate new burrows or renovate old one each year. On Prince Island the birds excavate their burrows as early as January, but egg-laying usually does not begin until early March. Laying may extend well into May, thus extending fledging times to late August.

Cassin's Auklet is an asynchronous breeder; while some early breeders have raised a chick by late May, others will have just laid eggs at this time. Typically, one egg is laid but the same pair may lay a second egg when the first chick is near fledging. Incubation, lasting about 38 days, is shared by both parents. Adults feed their chicks at the nest until the young fledge, between 41 and 45 day after hatching.

FIELD METHODS FOR PRINCE ISLAND

Parameter	Measurement
Abundance of breeding birds	Nest boxes that receive eggs
Phenology	Clutch or hatch initiation
Reproductive success	Surviving chicks

Areas to be censused

In January 1986, two artificial nest box complexes were established on Prince Island (see Figure 13). One is on the lower northeast side of the island just below the gull grids, the other is on the lower southeast side. These nest sites are to be examined at approximately monthly intervals throughout the breeding season.

Potential Problems

Monitoring of Cassin's Auklets on Prince Island poses problems of auklet burrow collapse and disturbance to other nesting seabirds.

In addition to access and logistical problems inherent to working the San Miguel Island area, Prince Island can often be difficult to work because boat captains are reluctant to subject their vessels, their crews, and themselves to the pounding usually necessary to reach this area during the early to mid nesting season from March through May. Therefore, monitoring leaders must remain flexible when scheduling operations at Prince Island and be prepared to charter a private vessel if scheduling conflicts arise. In the past charter vessels "Solera" and "Spirit", owned and operated by Peter Howorth (Santa Barbara, CA., telephone 805-687-2368) have been used.

Once at the island, landing may be treacherous at the north site but is usually easy at the south site (see Figure 13). When such conditions prevail, use of a small inflatable raft (Avon or equivalent) is recommended to land at the south site, then cross

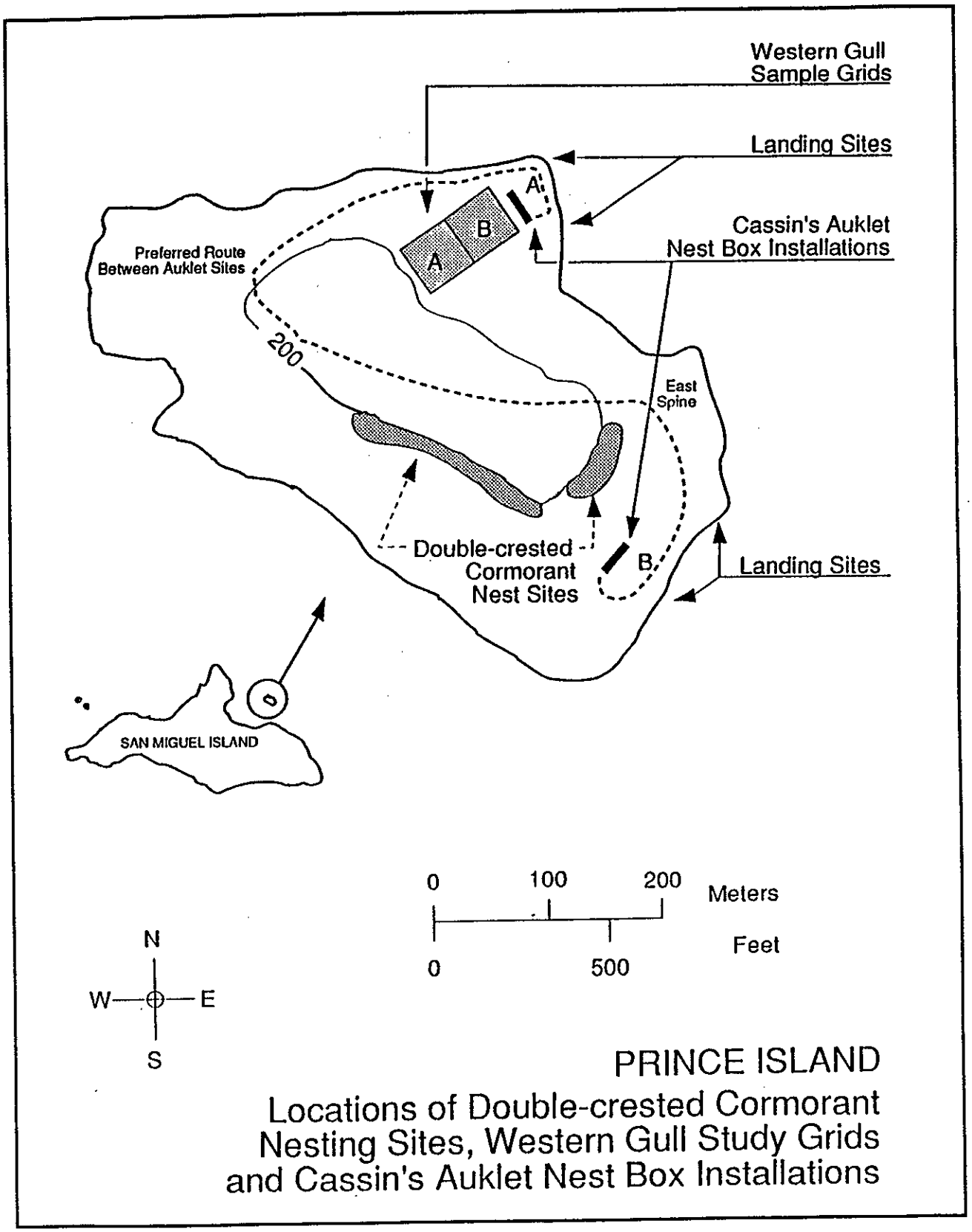
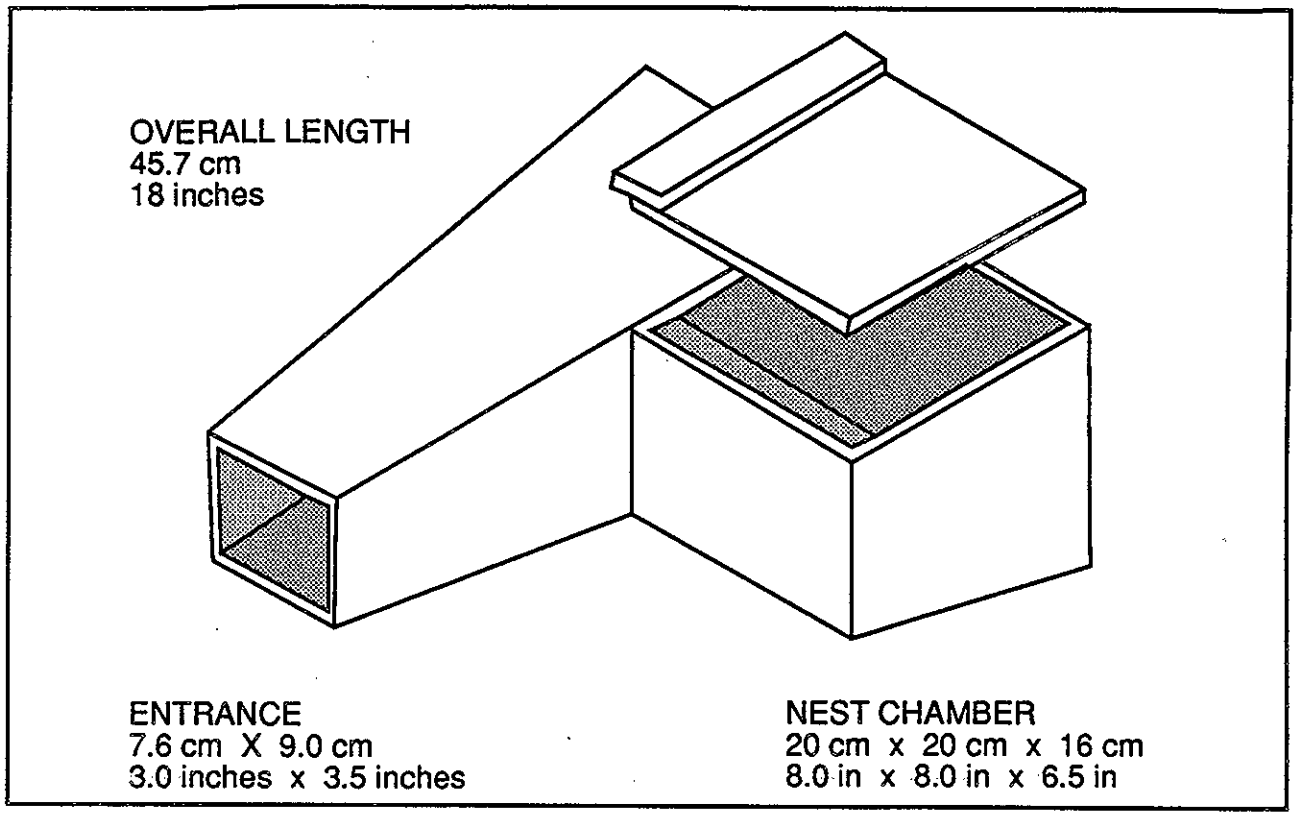
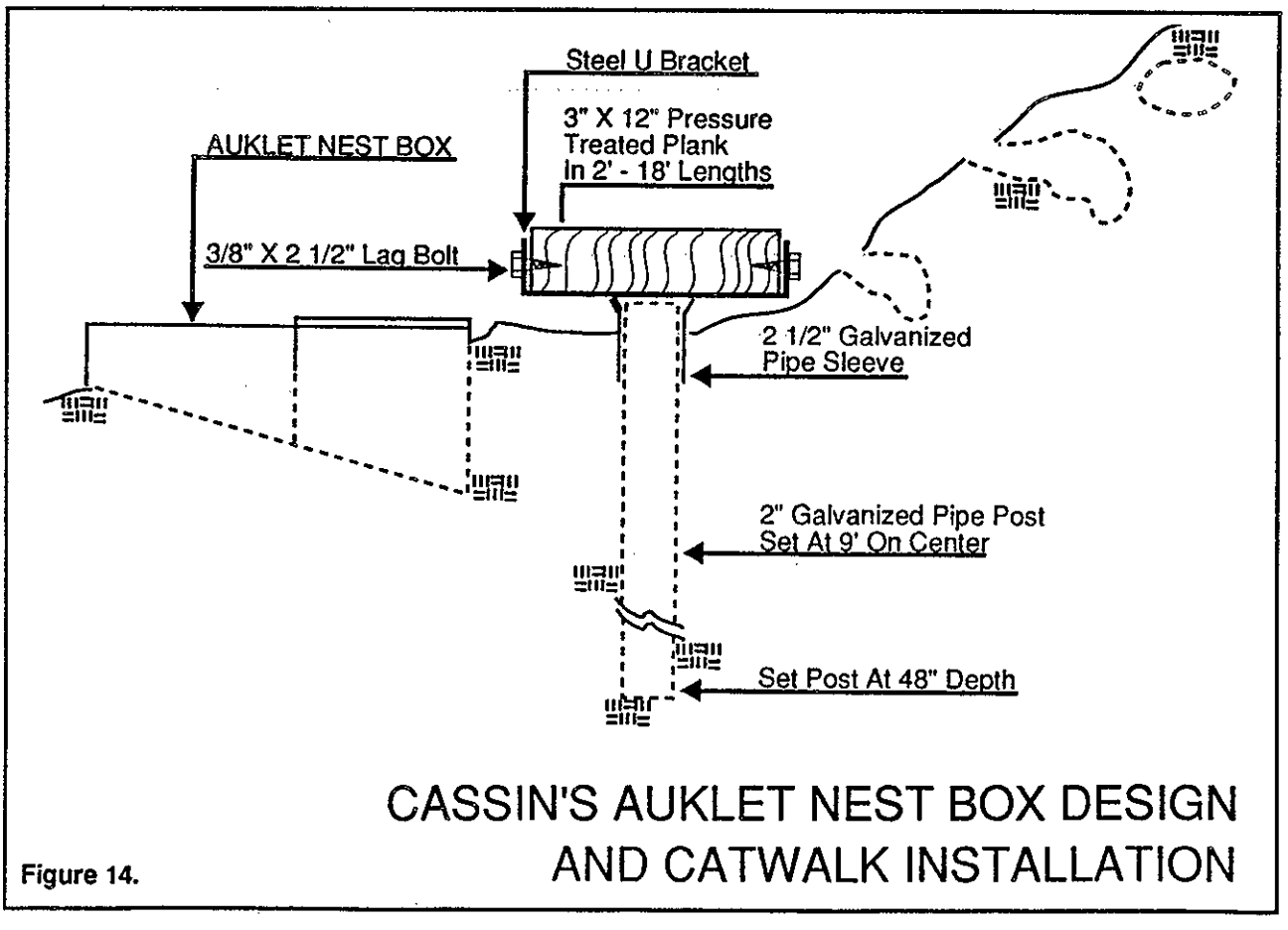


Figure 13. Cassin's Auklet Nest Box Locations - Prince Island





CASSIN'S AUKLET NEST BOX DESIGN AND CATWALK INSTALLATION

Figure 14.

the island to the north site. The preferred route (see Figure 13) goes east form below the south site along the shoreline boulders and rubble, then up and across the southeast talus slope to the east spine which must be climbed to reach the top of the island (be aware of Double-crested Cormorants nesting here.) Once on top proceed north across the flat summit to the northwest corner, then follow the rocky north spine down (east) toward Kidd Rock. Near the bottom traverse south across the area of loose soil below the nest box complex, being careful to stay below the auklet colony (burrows). Use the stepping stones below the south end of the boardwalk to reach the nest boxes. Be aware of nesting Brandt's Cormorants below this area and in the areas below the southeast talus slope (see below).

Auklet burrows are readily collapsed by foot traffic, with subsequent nest abandonment or mortality of resident birds. Although some burrow collapse is inevitable during the monitoring season, damage can be minimized by using exactly the same route on each visit and by using the boardwalks (Figure 14) during nest box inspections. For best access, approach each site from below and left of the boardwalk. At the north site a series of stepping stones leads up slope to the south end of the walkway from about 10 m below. These stones may have to be repositioned each year because of slope movement. At the south site, stay within the iceplant-covered area of the slope until you reach the large boulder at the west end of the boardwalk. When hiking over the top of the island (see route description above) choose vegetated rocky areas for walking; avoid areas of high burrow density in soft soil.

If burrows are accidentally collapsed, quickly excavate any debris blocking the burrow chamber to allow nesting birds to escape. If possible, partially reconstruct the burrow by covering the collapse with a flat rock, making certain to maintain access for the occupants.

Disturbance to nesting cormorants and gulls can be minimized by prudent strategy and cautious movements while on the island. Brandt's Cormorants regularly nest on the rocky lower perimeter of Prince Island but often shift colony sites between years. They will readily abandon nests if disturbed during the egg or chick phase of nesting. Always choose boat landing points and hiking tracks away from the cormorant sites, move slowly and deliberately within sight of nesting cormorants, and be prepared to abandon your activities if significant bailouts occur. Conceivably, in some years the potential, for cormorant disturbance could prevent access to the auklet nest box sites.

Double-crested Cormorants nest higher on the cliffs than Brandt's Cormorants and are thus less prone to disturbance from auklet monitoring activities. However, care must be taken to avoid their nesting areas while crossing the island. Be especially aware of appearing suddenly at the bluff edge on the west side of the island where the majority of the Double-crested Cormorants traditionally nest.

Although Western Gulls will not abandon nests in the face of incidental human intrusion, worker must take care not to step on eggs or small chicks in nests. As chicks grow, they may bolt from their nests, especially on the top of the island where cover is scarce./ In these circumstances it is usually best to keep moving deliberately through the colony, pausing to crouch occasionally to allow chicks to settle. A compromise must be maintained between minimizing the broad impacts of total disturbance time and the acute impacts of chick dispersal, keeping in mind such factors as cumulative disturbance and heat stress.

Recommended Methods

The difficulties in monitoring burrow-dwelling species are well-recognized (Hunter et al. 1982; Harris and Murray 1981; Savard and Smith 1985). Various sampling methods have been developed to estimate the abundance of some accessible burrowing species, but on Prince Island the destruction of Cassin's Auklet burrows is an added problem. Therefore, rather than attempt a massive sampling effort there has been established two nest box complexes each consisting of 25 plywood nest boxes and a 10 m boardwalk (figures 12 and 13). These nest boxes planted into the soil are readily used by auklets for nesting.

Two or three persons should be present for nest box checks. After carefully approaching the nest box site (see Potential Problems, above) walk along the boardwalk to sample nest boxes for contents on the

downhill side. Some boxes may be inaccessible from above so will have to be checked from below the boardwalk. Take care to avoid collapsing adjacent burrows. Use a small shovel and wide (4 to 6 inch) putty knife to remove accumulated soil debris from boardwalk and nest box tops.

Each nest box should be checked as follows:

1. Block the entrance with a small board to prevent birds from escaping.

2. Remove the rock weight from the box lid, then lift the lid slightly and peek in to locate any occupants, (usually found at the far end of the box).

3. If an adult or large chick is present quickly reach in and grab it (gently but firmly) and remove it for banding, measuring, and weighing. Adults are remarkable strong with sharp claws and can easily break any eggs present as they struggle to escape your grasp. To prevent egg damage be prepared for a sometimes painful struggle. Do not use gloves; they will decrease handling precision. If both an adult and small chick are present, process the adult first. Small chicks will stay quietly in the nest box and can be handled less forcefully.

4. All nest box occupants should be banded with USFWS Size #3 Stainless steel bands to document renesting, mate switching, chick growth and survival, and nest site fidelity. Chicks can be successfully banded at about 5 days old; prior to this use a temporary Velcro band or web tag. Banding requires a permit or must be done in cooperation with a USFWS licensed bander. You cannot band birds under any other circumstance.

5. After banding, measure the culmen depth (to 0.1 mm - adults only) exactly at the anterior edge of the nares, using precision calipers. This is a tricky measurement, especially with uncooperative birds, and should always be performed by the same person to encourage consistency. Within paired adults, this measurement is larger in males than females and thus enables determination of sex.

6. Chicks, adults and eggs are weighed in a small nylon bag using 100 g or 300 g Pesola spring scales. Note the iris color of adult birds. Adults have white irises, whereas those of immature birds are brown or flecked. Carefully measure the length and width of eggs to within 0.1 mm. Check eggs for addling by gently shaking them next to your ear and listen for sloshing liquid. If eggshell fragments are found, determine whether they are from hatched or broken eggs, using the criteria described for Xantus' Murrelets (q.v.).

7. After processing, replace the egg or chick in the nest box, reset lid and rock weight, and remove entrance block. Adult birds should be released into the entrance hole to re-enter the box themselves. Since adults switch incubation shifts overnight, repeat these operations (adult birds only) the next day, and check unoccupied boxes for new nesting.

Monitoring Schedule

Monitoring on a monthly basis should begin in late February and continue at least through the chick phase in June and July. The frequency of counts may need to be increased if these data are unsatisfactory.

Boardwalk and nest box maintenance should be done during the non-breeding season (September - December) so when auklets excavate new burrows as early as January, nesting activities will not be interrupted.

Time Required

Nest box inspections take one to two hours per site, depending on number of birds present, and amount of excavation and banding required; the trans-island hike takes about a half hour each way. Therefore allow four to five hours on the island for each trip. Annual maintenance of the nest boxes and boardwalk can probably be completed in one day.

Recording Data

See Appendix B-4 for a sample data form used to record Cassin's Auklet monitoring information. Nest boxes are numbered from the left at the south complex, but from the right at the north complex. (i.e., at the south complex nest box number 1 is westernmost; at the north complex, box number 1 is northermost.) Record nest box activity status and contents, weights, measurements, sex of adult birds,

iris color, banding information, and remarks in the appropriate columns. The following abbreviations are used:

Nest Status:

A = Active; box contains adult, egg, or chick.

P = Prospected; fresh tracks, feathers, or excavation.

U = Used; knowledge or evidence of nesting during current season (shell fragments, addled egg or dead chick).

Ø = Empty; no sign of current activity.

Nest Contents:

A = Adult		C = Chick	
E = Egg		DC = Dead Chick	
AE = Addled Egg		F = Feathers	
BE = Broken Egg		Ø = Empty	
HE = Hatched Egg			

Safety

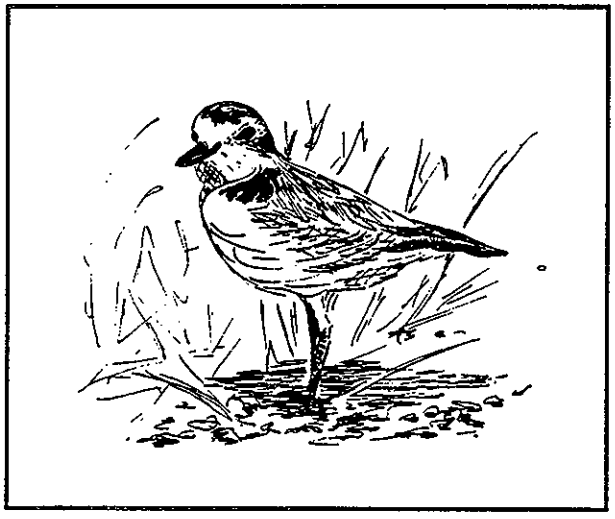
Figure 13 shows landing sites that have been used with success in the past. Landings should be attempted only in relatively small swells and with an experienced boat navigator.

When climbing on the island, be prudent and cautious; beware of unstable foot and hand holds.

Special Equipment

1. Pesola scales (100 g and 300 g) and two nylon bags for weighing birds.
2. Small shovel and wide (4" - 6") putty knife for nest box and boardwalk excavation.
3. USFWS (#3SS) and Velcro bands, and banding pliers.
4. Precision calipers for culmen and egg measurements.
5. Two small (30 cm x 30 cm) boards, (plywood or masonite) to block nest box entrances.

SNOWY PLOVER



Breeding Biology and Plumage

Snowy Plovers are small, pale, sand-colored shorebirds that inhabit sparsely-vegetated sandy areas (shores and dunes) on San Miguel, Santa Rosa and Santa Cruz islands (Spear 1981). Their nests, which are inconspicuous and extremely difficult to locate, appear as slight depressions in the sand often near shells, vegetation, rocks or driftwood.

The breeding season lasts from April to July. Usually three eggs are laid, but often there are only two; both parents incubate and care for the young. Snowy Plover will often feign injury to distract intruders from the nest site, a tactic that may be effective in evading the numerous island foxes (*Urocyon littoralis*) on the Channel Islands. Adults forage along the water's edge, and when going to or from the surf line they do so with distinctive rapid movements; like other plover species, they start, run several feet, then abruptly stop.

Adults can be differentiated from juveniles by having distinctly dark shoulder, facial, and forehead markings, whereas the juvenile markings are indistinct and appear washed out. Adult male marking are noticeably darker than those of females.

FIELD METHODS FOR SAN MIGUEL ISLAND

Parameter	Measurement
Abundance of individual birds	Birds on beach or in flight
Abundance of breeding birds	Numbers of females on beach

Areas to be censused

The bold lines on the map in Figure 15 show the areas of beach accessible for censusing Snowy Plovers on San Miguel Island. The remaining beaches on the island are narrow and covered with water at high tide, support haul-out or breeding areas for pinnipeds, or are not accessible by foot for censusing.

In recent years (since 1985) increasing numbers of molting northern elephant seals (*Mirounga angustirostris*) and breeding harbor seals (*Phoca vitulina*) on the south beach areas (Crook Point to Cardwell Point; see Figure 15) have probably reduced Snowy Plover nesting in that area. If pinniped occupation of the south beach area increases plover nesting could be eliminated. Monitoring, however, should continue, but observations in areas of pinniped occupation (especially where harbor seals are breeding) should be conducted with considerable caution to minimize disturbance.

For each survey period, begin the plover censuses at Simonton Cove, reached by trail from the ranger station. The trail is usually overgrown in the spring. Begin the survey at "Hidden Cove", a small beach northeast of the main beach area of Simonton Cove. "Hidden Cove" is reached by climbing the rocky outcrop at the northeast end of Simonton Cove and dropping down into an amphitheater where the Snowy Plovers nest. After surveying "Hidden Cove" climb back over to Simonton Cove and continue to survey southwest along the beach to the southern terminus ("Demarcation Beach") where the beach is interrupted by a rocky headland. Snowy Plovers may be found anywhere on this long strand. Look for nesting pairs on the upper part of the beach in

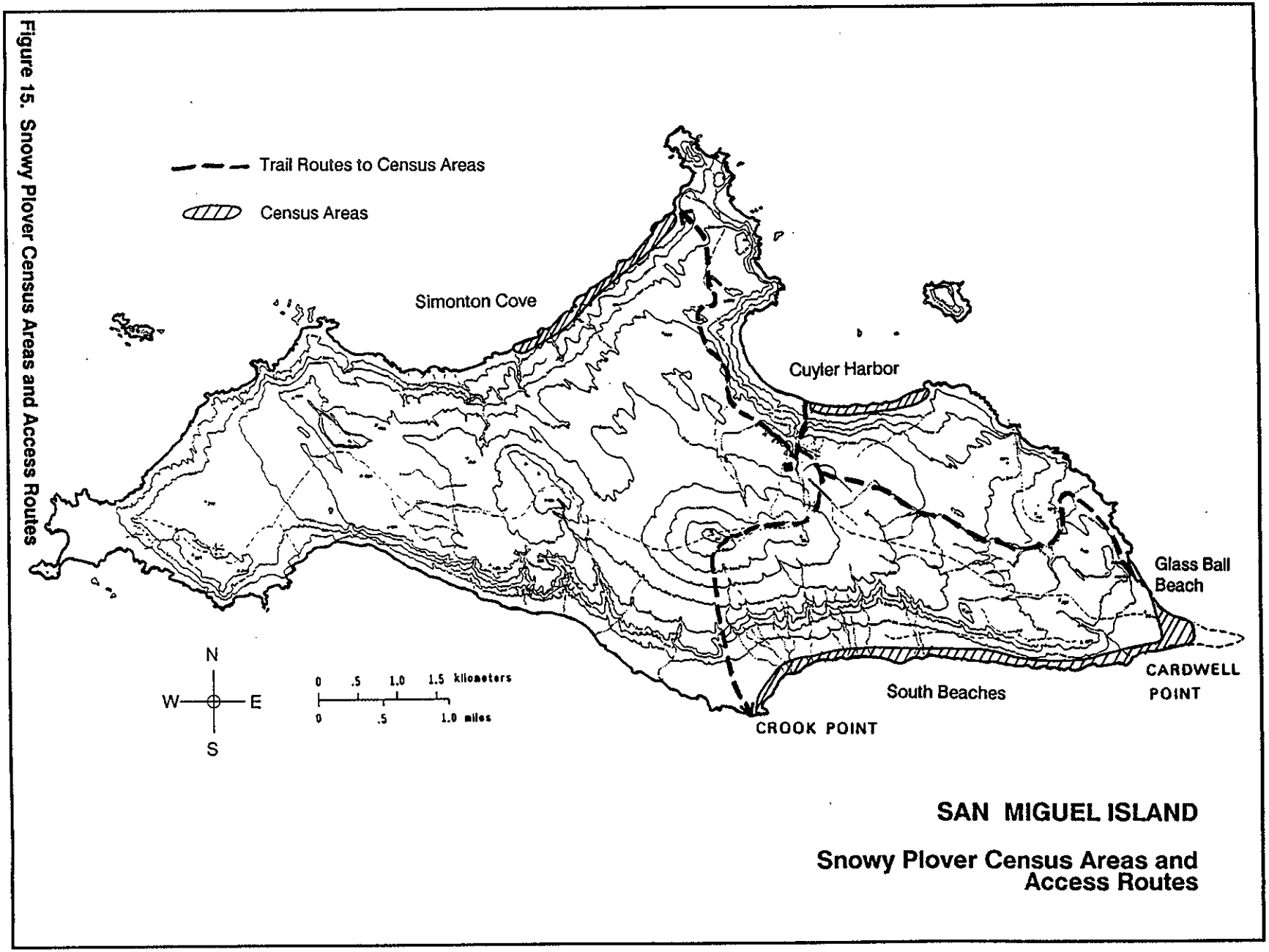


Figure 15. Snowy Plover Census Areas and Access Routes

this area by walking along the lower edge of the sandy hillocks above the beach.

The Cuyler Harbor survey area is reached from the ranger station via the Nidever Canyon trail to the beach. As you reach the beach, proceed eastward and begin the plover census. About halfway to the end of the beach you must skirt a rock outcropping; it is possible to cross this area only at low tide. Most of the plovers are located at the easternmost end of the beach.

The South Beaches area are best reached via a trail from the ranger station to the top of San Miguel Hill, then cross-country southward down the steep slopes to Crook Point. Start the census from the western point of a small bay to the west of Crook Point; plovers are nearly always seen here along a 100 m stretch of beach just east of the rocky coast comprising the eastern end of Tyler Bight.

Cardwell Point is a good Snowy Plover breeding area but it is difficult to survey due to its width thus increasing the possibility of double counting of birds. Once you know where the plovers are aggregating, you can concentrate censusing efforts there in subsequent surveys. Although there is no nesting on the outer point (most nests are located toward the bluff at the west end of the beach) many birds are often seen feeding there.

Methods

Potential Problems

Locating Snowy Plover nests is very difficult because they are very small and cryptic. In addition to sandy beaches, nesting also occurs above the littoral zone and in dunes, sometimes to an elevation of 15-30 meters. Looking for nests, therefore, to serve as an index of nesting effort is not realistic; most nests can not be found without prohibitive time investment, if at all. Moreover, island foxes may inadvertently be led to nest sites by human scent.

The birds themselves are also quite difficult to see, especially on a bright day when the sun reflects from the sand. Their uniform sand colored upper surface effectively camouflages them when they are standing still and they are readily visible only when moving (i.e., walking or running) or when in flight.

The potential of disturbance to pinnipeds that also use the beaches is also a problem, especially on the South Beaches. At this time of year elephant seals are sometimes densely packed on the beach while molting (not breeding), while harbor seals are breeding or caring for small pups in smaller groups. On the South Beaches even the most cursory plover census from a distance will cause some disturbance; it cannot be entirely avoided. One can, however, minimize disturbance by moving cautiously. When elephant seals are on the beach work around and through them slowly without forcing them to move; they will be relatively unaffected if you are move slowly and deliberately. Harbor seals, however, are nearly impossible to not disturb. If possible, allow them see you at a distance so they won't be as startled. Walk slowly and give them time to slip into the water without panic; they will always move into the water when they sight you. Observers should then pass by the pups as quickly and inconspicuously as possible to allow the adult to return to them.

Walking along the top of the bluffs overlooking the South Beaches to avoid pinnipeds is not necessary; disturbance to harbor seals is probably not significantly lessened by taking this route. The only way to minimize the impact of your presence on these extremely skittish animals is to minimize the number and duration of surveys.

Strong winds, fog, glaring sun, and reflection from white sand can make censusing extremely difficult. Censuses should be postponed if fog is too thick to see plovers (less than 200 m visibility) or if winds exceed about 15 knots.

On the upper (northeast) area of Simonton Cove beach, move particularly slowly and be very careful where you walk, as it is easy to step on a nest accidentally. Nests in this area seem to be more vulnerable to the effects of human presence (disturbance, destruction of nests, and attraction of foxes) than in the other survey areas. If nests are sighted, it is important to stay away from them. Never pick up and handle eggs.

Recommended Methods

Most of the census work can be done by one person, although with two people, surveys are easier and more efficient. Surveys on Cardwell Point and Glass Ball Beach almost always require more than one person to do an adequate census.

Since Snowy Plover nests cannot easily be found, and because of the probability of attracting foxes to nests, it is recommended a count of females be taken as a measure of the number of nests. Males and females are sufficiently dimorphic that with a little experience, they can be readily differentiated in good viewing conditions.

It has been found that the best method for obtaining data is to walk slowly along each survey beach as high up on the beach as possible; this will usually flush plovers down to the lower part of the beach. Stop every 50-75 m and scan the area in front and to the side of you with binoculars, but not behind (to avoid double-counting) except to sex or age birds which fly past. Pay particular attention to pebbly areas and to areas where piles of seaweed are lying on the beach; these are favorite hiding places for plovers. Look carefully - plovers are hard to see.

The above method works well on relatively narrow beaches. However, Cardwell Point and Glass Ball Beach are wider beaches than a single observer can effectively census. At Cardwell Point, two observers should walk side by side, moving simultaneously and stopping each 50-75 m while slowly progressing eastward more or less through the middle of the beach area. After crossing the point, turn northward and continue as before through Glass Ball Beach. Wind and glare are particular problems in this area.

Monitoring Schedule

Begin censusing plovers in April and continue through July as follows:

- one survey in April,
- two each in May and June (when nesting activity is greatest), and
- one in July.

A minimum of two full days are needed to census all four areas. But because of unpredictable weather conditions, several days on San Miguel may be required to complete the surveys. It is important, however, to census all survey areas within a two to three day period, if possible, to minimize movements of birds between areas and thus avoid double-counting.

The best time for censusing plovers is between 1000 and 1400 hours for the most favorable weather conditions and when plovers are active. Don't start too early in the morning.

Time Required

Approximate times required for each survey area are summarized as follows:

- Simonton Cove: 2 hour travel + 2 hours survey
- Cuyler Harbor: 1 hour travel + 1 hour survey
- South Beaches/Cardwell Point/Glass Ball Beach: 3 hours travel + 4 hours survey

Recording Data

Record the number of males, females and juveniles by survey area. When nests are found, make note of contents (number of chicks or eggs). A sample field data form for Snowy Plover surveys is shown in Appendix B-1.

Safety

Unless monitors are familiar with San Miguel Island, it is easy to get lost, especially in foggy weather. Always carry a compass and a contour map of the island showing trail locations. Weather conditions on San Miguel Island can change suddenly and dramatically. Dress in layers and bring clothing to protect against wind and cold. Carry sun screen and wear a hat for protection against the sun. Bring sufficient water and food for the long South Beaches/Cardwell Point/Glass Ball Beach surveys.

DATA MANAGEMENT

The data generated by most of the field methods outlined in this handbook are conducive to statistical analyses for determination of interannual changes in nesting parameters. Normally, one might use the familiar Student's t-test to detect significant differences in annual population and productivity means. However, seabird breeding distributions are distinctly clumped, our sampling methods are systematic (not strictly random), and sample variances have not proven to be equal. We have therefore chosen to use non-parametric statistical tests. In particular, we recommend use of the Mann-Whitney U test for comparisons of individual years or the Kruskal-Wallis one-way ANOVA for comparing multiple years (Siegel 1956). These or similar statistical tests are available in packaged statistical programs compatible with MS-DOS (IBM-compatible) personal computers (e.g., SAS 1987; SPSS 1983). The reader should refer to Wanless et al. 1982, and Hatch and Hatch, 1988, for insights into detection and analysis of annual changes in seabird populations.

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Appendix A-1: Plumage Changes in Young California Brown Pelicans

Plumage characteristics of Brown Pelican chicks as they change weekly (from hatchling to fledgling) are described below. At hatching and for the first week, chicks are naked with dark purple/black skin. Down appears on the back and rump in 10 to 12 days and chicks appear grayish. They are completely covered by white down by the third week. The first dark feathers to emerge are the scapulars and primary wing feathers which begin showing about 30 days after hatching. As feathers begin emerging and growing, young pelicans increasingly appear more brownish as down disappears. Most of the down is gone by week 10, and by the time of fledging, the head, neck, and back are brown, while the breast remains white. Newly-fledged birds may be confused with sub-adults hatched in the previous year, especially by inexperienced observers at a distance. Distinguishing characteristics between these two groups are given at the bottom of the table.

AGE CATAGORY	WEEK	CHARACTERISTICS
I.	1.	Purple-black, naked; uncoordinated, closely brooded.
	2.	Gray, down emerging; head and neck naked; closely brooded.
	3.	White, downy.
	4.	White, downy, but larger.
II.	5.	White, downy, but with first feathers emerging on wings and back (primaries and scapulars); gray-brown beginning to show on back.
	6.	Wings totally with emerging feathers; back appearing gray-brown.
	7.	Wing feathers 1/4 grown in; belly downy; head and neck mostly downy, but duskiness beginning to show.
	8.	Wing feathers 1/2 grown in; belly with emerging feathers; head and neck 2/3s down, rest dusky.
III.	9.	Wing feathers 3/4 grown in; upper belly 1/2 feathered; head and neck 1/2 downy, rest dusky.
	10.	Wing feathers complete; some down on lower belly and under wings; head and neck mostly gray-gray, but still lighter than that of fledged young.
	11.	Last of down (under legs and wings); head and neck a more uniform brown.
	12.	Full feathering; has ability to fly.

Young-of-the-year characteristics:
Light brown head and neck; overall appearance of clean, new feathers; clean white belly; back and wing feathers a rich, light brown with slight scaly appearance; line between dark and light on sides appears indefinite; yellowish feet; soft parts of head gray without color.

Second-year juvenile characteristics:
Darker, dull brown head and neck; overall appearance of scruffiness and worn feathers; white belly, but often soiled; back and wing feathers uniform dark, dull brown; line between dark and light sides distinct; pouch and feet gray; bill with orange or red tip.

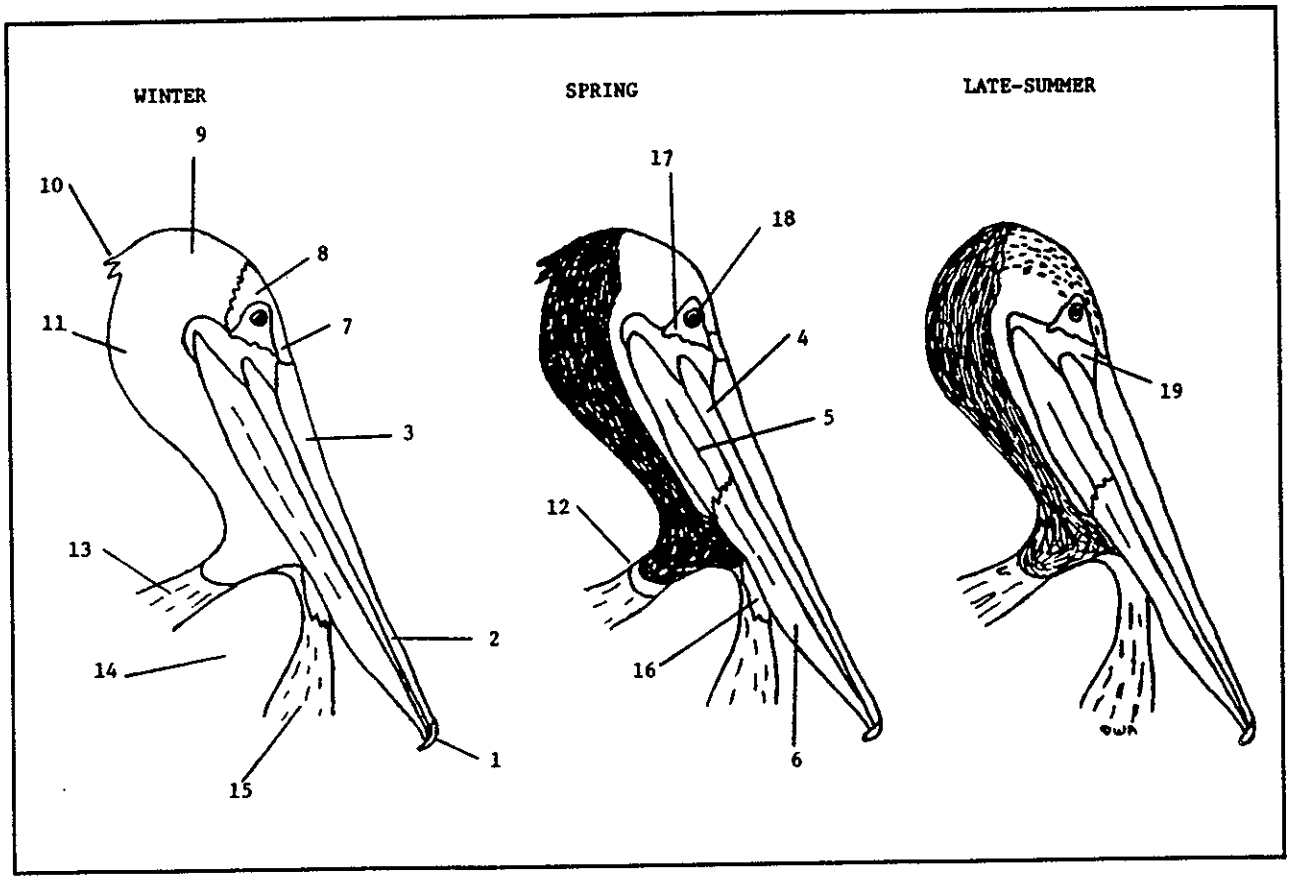
Appendix A-2: Seasonal Changes in Adult California Brown Pelicans

Intensity of colors, especially in the fleshy parts, is greatest in adult and older-adult pelicans; once acquired, the greater intensities tend to remain. There is much age-related variation in the younger birds tending toward more brown feathers and less intense colors. The complex changes in appearance of the adult California Brown Pelican through one annual cycle, as related to molt, feather wear, and physiological condition are described below. Various zones in the head region are coded to the accompanying illustration shown on page A-3 and changes in these zones are outlined below.

Colors of soft parts during seasonal changes in appearance of adult California Brown Pelican. Taken from Anderson and England (1987) and D. W. Anderson (unpublished field notes).

Area--Description	Winter (pre-breeding)	Spring (breeding)		Late-Summer (post-breeding)	
	Appearance	Appearance	Change	Appearance	Change
1 -- Nail	yellow	bright yellow	hormonal	yellow	hormonal
2 -- Upper mandible (distal)	yellow/some orange	yellow/orange pink/red	hormonal	yellow/some orange	hormonal
3 -- Upper mandible (proximal)	light blue	light blue/ pinkish	hormonal	grey-blue	hormonal, shedding
4 -- Lower mandible	light blue	light blue	hormonal	grey-blue	same
5 -- Gular pouch (proximal)	reddish orange	bright red	hormonal	yellow-grey	hormonal
6 -- Gular pouch (distal)	grey-green	deep green	hormonal	grey	hormonal
7 -- Forehead	yellow	yellow	molting	salt & pepper	molt
8 -- Lower crown	yellow	white	molt	salt & pepper	molt
9 -- Upper crown	white	white	none	salt & pepper	molt
10 -- Crest	white	dark brown	molt	reddish brown (if present)	wear
11 -- Occiput & nape	white	dark brown	molt	medium brown	wear
12 -- Upper back	white	to dark brown	molt	medium brown	wear
13 -- Mid-back	silver-grey	silver-grey	none	dull brown	wear, molt
14 -- Wing coverts	silver-grey	silver-grey	none	dull brown	wear, molt
15 -- Upper breast	grey-brown	dark brown	wear	scruffy, flecked, dull brown	wear, molt
16 -- Jugulum	yellow	yellow	wear	very faded	molt, wear
17 -- Eye-ring	grey	pink	hormonal	grey	hormonal
18 -- Iris	light blue	light blue	none	brownish	hormonal
19 -- Lore	grey	grey pink	hormonal	dark grey	hormonal, shedding

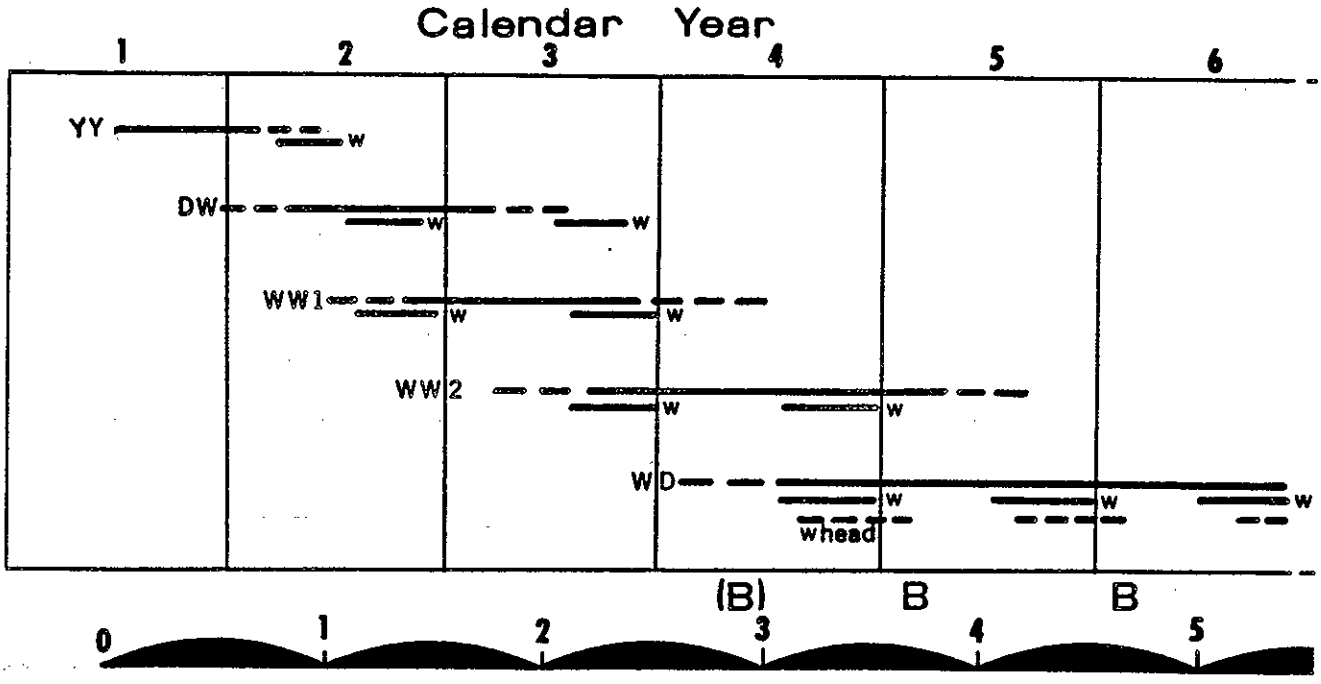
Appendix A-2: continued



Appendix A-3: Five Age Classes of California Brown Pelicans

Five age classes of the California Brown Pelican can be distinguished by external characteristics. The following table describes yearly molt patterns and plumage/soft part changes for each age class. Adult (breeding) plumage is usually attained in the fourth year. As shown in the figure, age classes are designated by abbreviations which are also used in field notes.

Molt pattern and plumage changes in the California Brown Pelican.
Taken from Anderson and England (1987) and D. W. Anderson (unpublished field notes.)



Bars indicate period when molt is occurring.

Abbreviations are as follows:

YY =	Young-of-the-year	Brown head, white belly; all soft parts on head grey without color; feet yellowish; line between dark and light on sides appears hazy.
DW =	Second-year bird	Dark head, white belly; feet greyish; yellow bill tip; line between dark and light on sides more distinct.
WW1 =	Early-stage third-year bird or late-stage second-year bird;	White head, white belly; head has appearance of faded adult; this is an intermediate stage plumage that is quite variable, and may last longer in males than in females.
WW2 =	Third or fourth-year bird	White head, white belly; distinctly adult type head with patch of white remaining on belly.
WD =	Full adult	White head, completely dark belly, typical adult head.
(B) =	Breeding	May begin in third year, particularly with females.
B =	Breeding	Usually begins in fourth year.

Appendix B-1: Seabird Nest Contents

SEABIRD NEST CONTENTS

Island SBI GRID GUW 'A' 1995 P. 1

Species Western Gull 1987

Nest No.	20 April (DBL)	28 April (DBL/CD)	21 May (CD/CF)	30 May (DBL/CD)	6 June (DBL/VIP)	12 June (CD/CF)					Comments
A1	C_1	C_3	P_2B_1	B_3	B_2	B_2					
A2	C_1	C_3	B_3	B_2D_1	B_2	B_2					
A3	C_2	C_2	D_1B_1	B_1	0	0					
A4	C_1	C_3	C_3	B_3	B_2	B_2					
A5	C_2	C_2	A_1C_1 (1)	A_2 (2)	0	0					(1) Egg Broken (2) One broke, one addled
A6	C_1	C_3	P_3	B_3	B_3	B_2D_1					
A7	C_2	C_3	$P_1B_1C_1$	B_2A_1	B_2	B_2					
A8	C_1	C_3	P_1C_2	B_3	B_3	B_3					
A9	C_1	C_2	C_3	B_2D_1	B_2	B_2					
A10	C_3	C_3	B_3	B_3	B_3	B_3					
A11	C_1	C_2	C_2	B_2	B_2	B_2					
A12	C_2	C_3	P_2C_1	B_3	B_2D_1	B_2					

EXAMPLE

Appendix B-2: Western Gull Nest Data - Santa Barbara Island

WESTERN GULL NEST DATA
SANTA BARBARA ISLAND

Observer _____ Date_____19_____

	Census Area	From Viewpoint	Nests or Birds on Nests	Individuals	Total
I.	Landing Cove	1			
		2B			
		Raft			
II.	Arch Point	2A			
III.	Shag Rock	3			
		4			
IV.	Elephant Seal Cove	4			
		5B			
V.	North Cliff	5A			
VI.	Webster Point	6			
VII.	A1 Cliff	7			
VIII.	A1 Area	8			
IX.	West Colony	9A			
		9B			
X.	Badlands	10			
XI.	Cat Canyon	11			
XII.	SE Sea Lion Rookery	12A			
		12B			
		12C			
		12D			

EXAMPLE

Appendix B-3: Western Gull Chick Growth and Food Data

WESTERN GULL CHICK GROWTH/FOOD

Island ____________________ P. ________

Grid '________' 19 ________

Band #'s	Nest #	Wt.	Fd.	Wt.	Fd.	Wt.	Fd.	Wt.	Fd.	Wt.	Fd.	Wt.	Fd	Remarks

Appendix B-4: Cassin's Auklet Nest Box Survey

CASSIN'S AUKLET NEST BOX SURVEY

Island Prince Island Time 1046-1355 Date 16 June '88

Observer PBL/DCB Wx O'cast, calm, T~ 65°F

Nest Box #	Stat	Cnts	R=recap Band # (L-Leg)	Cul Dpth	Sex	Iris	Fd	Grs Wgt	Net Wgt	Egg L x W	Remarks
1	U	Ø									
2	Ø	Ø									
3	U	BE									
4	A	BE+C	1313-14796			B	–	148	118		Chick missed yesterday
5	Ø	Ø									
6	U	HE									
7	U	Ø									Active last month (A+E)
8	U	Ø									Active last month (A+E)
9	Ø	Ø									
10	A	A+E	Ⓑ-14755	10.0	♂	W	–	193 59	163 29	93.5 x 33.4	
11	P	BE									Egg addled (AE)
12	Ø	Ø									Feathers
13	P	F									
14	U	BE									
15	A	A C	-14797 14791	9.0 –	♀ –	W B	– –	179 74.5	149 94.5		Adult baited after replaced in box. Chick band OK.
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											

EXAMPLE

Iris: W= White, F= Flecked, B= Brown

Status: (Stat) U= Used, P= Prospected, A= Active, Ø= Inactive, D= Disturbed/ Damaged

Contents: (Cnts) A= Adult, E= Egg, C= Chick, A+E= Adult + Egg, AE= Addled Egg, HE= Hatched Egg, BE= Broken Egg

Culmen Depth: taken at anterior edge of nares.

Wgt-Tare= 30g

Appendix B-5: Snowy Plover Field Data - San Miguel Island

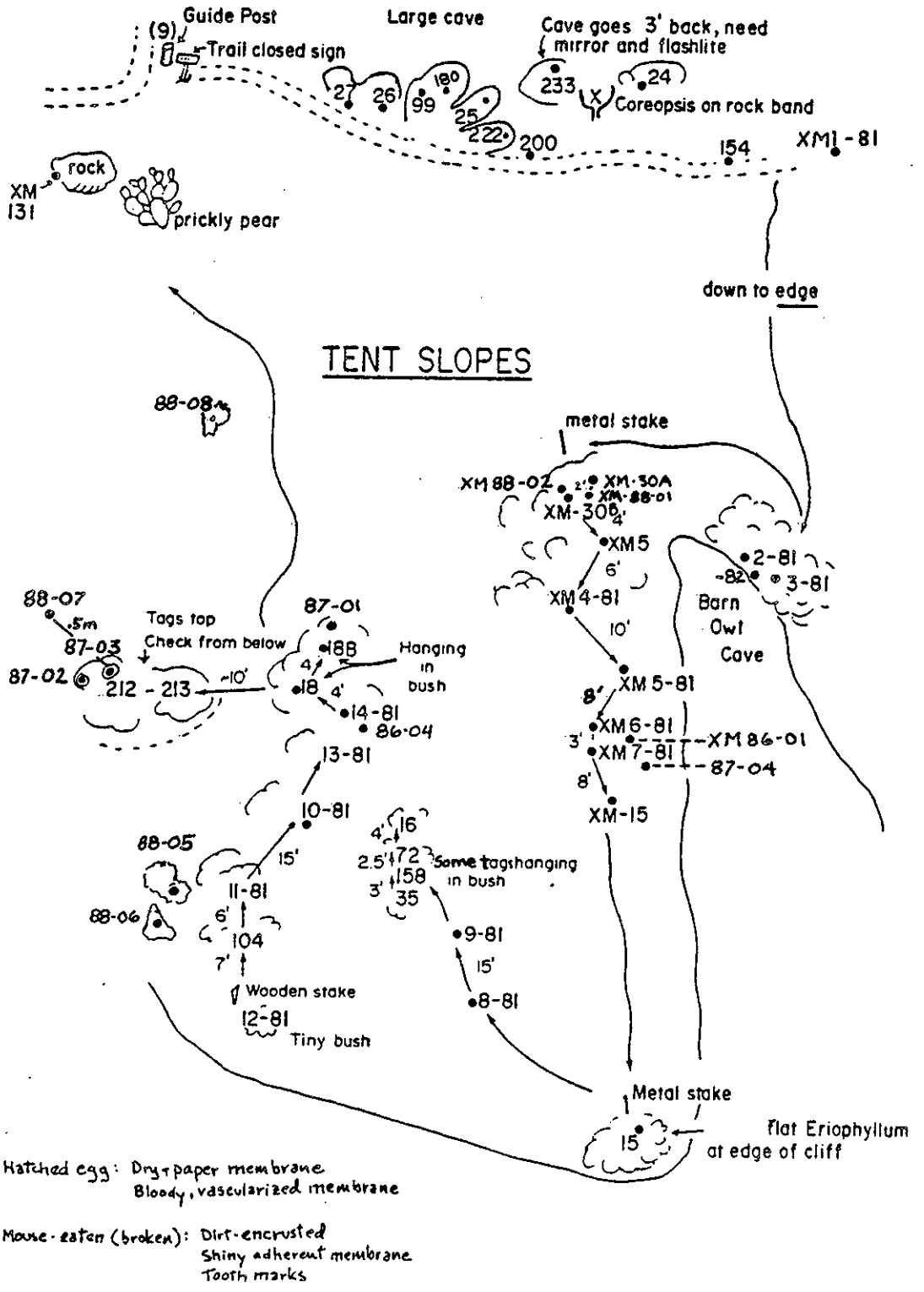
SNOWY PLOVER SURVEY - FIELD DATA SHEET
San Miguel Island

Time Start _____ Date 25 June, 1987 Page 1
Time Stop _____ Observer C.R. Cutler
Wind Speed/Direction _____ Visibility _____ Sky Condition _____

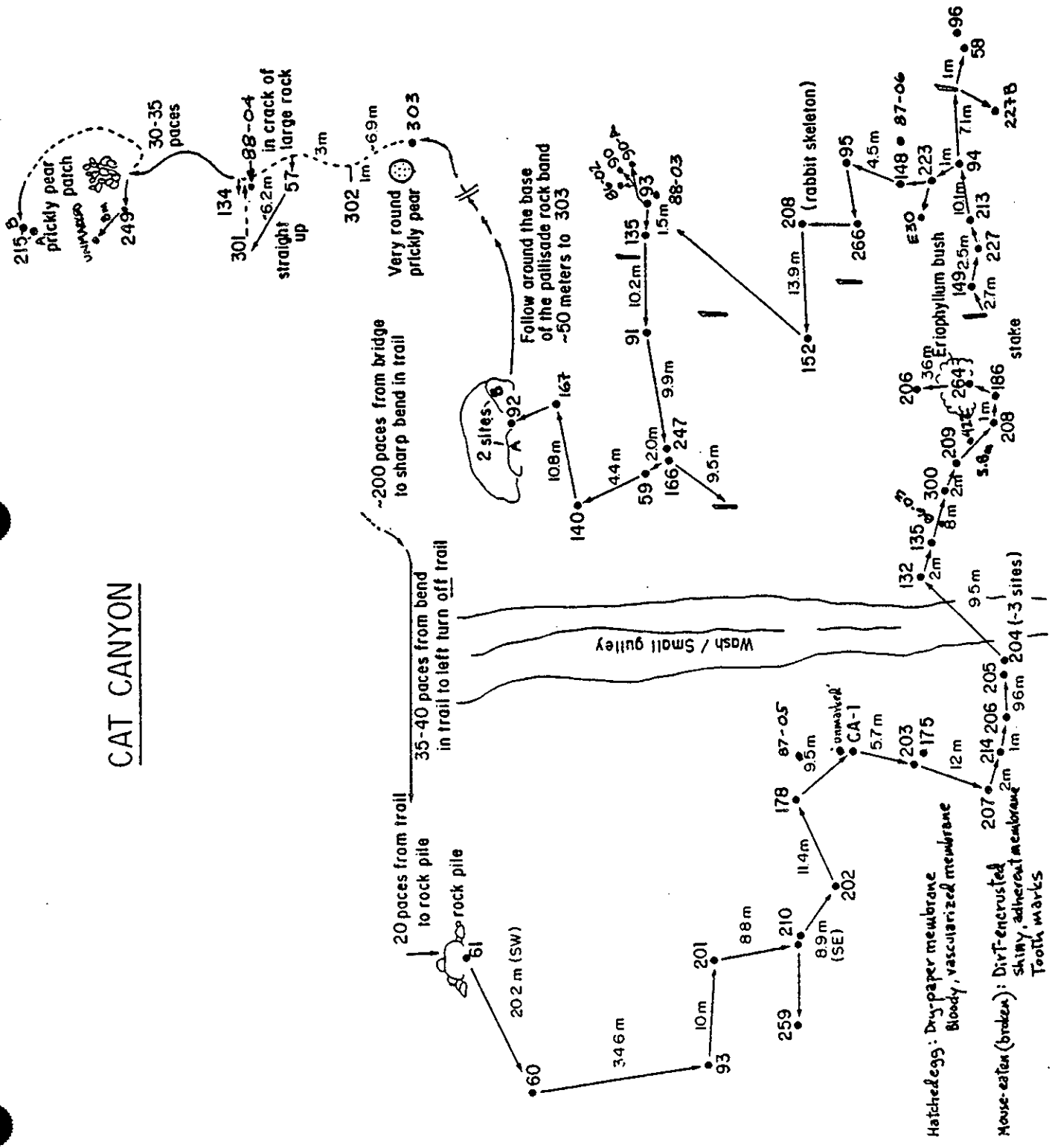
Location	Male	Female	Paired Y=Yes N=No	Fledged Young	Nest	Contents	Notes/Remarks
200 m E. of Nidever Cyn. trail jct. with Cuyler beach	1	1	y	-	(1)		① observed this tightly bonded pr. for 35 min. ♂ walked around ♀ a few times as if about to mount her. She was not receptive and remained still in a nest scrape lacking contents
500 m E of above	♀	1	-	-	-		Ran down beach to the E. Upon reaching cliffs turned & flew W. along shore with 4 ad. Black Oystercatchers.
30 m from E. end of Cuyler Beach	2	1	N	-	-		3 birds walked around together for 5 min. & then, as I stood 70 m. from them, they flew SE over dunes. One ♂ gave "prrt" call

EXAMPLE

Appendix C-1: Burrow Locations - Tent Slopes, Santa Barbara Island



Appendix C-2: Burrow Locations - Cat Canyon, Santa Barbara Island



Appendix D: Data Analysis and Reporting Guidelines

Analysis and reporting of seabird monitoring data collected each year takes the form of an annual report to the Park. The kinds and quality of data collection varies each year, depending on the extent of seabird breeding efforts, and on manpower, budget, and logistical limitations. For example, large protracted nesting efforts by pelicans on both Anacapa and Santa Barbara islands, together with cutbacks in seasonal specialist hiring could preclude the attainment of complete data sets from, say, the gull grids. Conversely, minimal pelican nesting activities might allow extra visits to the auklet study complexes on Prince Island. Thus data analysis as reflected in annual reports is influenced by both the whims of nature and by managerial decisions.

The annual report should be written from the standardized outline shown in Table D1. The contents of each major heading is briefly described below.

ABSTRACT. The abstract is a brief, concise synopsis of the salient contents of the report, including pertinent recommendations. It should be less than one page.

INTRODUCTION. The introduction provides background information on the seabird monitoring program and its goal and function within the Channel Islands National Park.

METHODS. This section refers the reader to the seabird monitoring handbook and to the Species Accounts for descriptions of methodology.

Table D1. Outline for annual report of seabird monitoring to CINP.

Title Page

I. Abstract

II. Introduction

III. Methods

IV. Results and Discussion

A. Species Accounts

1. California Brown Pelican
   a. Anacapa Island
   b. Santa Barbara Island

2. Double-crested Cormorant
   a. Anacapa Island
   b. Santa Barbara Island
   c. Prince Island

3. Pelagic Cormorant
   a. Anacapa Island

4. Western Gull
   a. Anacapa Island
   b. Santa Barbara Island
   c. Prince Island
   d. Gull Island

5. Xantus' Murrelet
   a. Santa Barbara Island

6. Cassin's Auklet
   a. Prince Island

7. Snowy Plover
   a. San Miguel Island

B. General Discussion

V. Conclusions and Recommendations

Acknowledgements
Literature Cited
Figures
Tables
Appendices

RESULTS AND DISCUSSION. This combined section includes a series of detailed Species Accounts in which the year's seabird reproductive data are summarized by species and island, and a more broadly synoptic General Discussion section. Each Species Account presents brief methodology and sampling effort summaries and also discusses the data obtained for that species. The General Discussion integrates inter-specific and inter-island topics such as food availability, pollutants, and oceanography with the reported data, as well as making comparisons with prior years, other species or other ecosystems.

CONCLUSIONS AND RECOMMENDATIONS. This section draws conclusions about inter-annual fluctuations and long-term trends and makes recommendations for management plans or for more detailed investigations of perceived problems. It also recommends changes in the monitoring program or its protocols.

Since the annual reports are primarily archival documents, data analysis is usually minimal and consists mainly of simple data reduction processes and descriptive statistics. Following is a summary of expected analyses for each species:

BROWN PELICAN

Nesting effort and productivity summaries:

A. Number of:
1) nest attempts
2) young fledged
3) successful nests
(=nest attempts minus abandoned nests)
4) dead chicks (mortality)

B. (from A above) Calculate:

1) Productivity
(=young fledged per nest attempt)

2) % successful nests
(=successful nests per nest attempts)

3) Young fledged per successful nest

4) % chick mortality

DOUBLE-CRESTED CORMORANT

Nesting effort and productivity summaries:

A. Number of:
1) Nest attempts

2) Young fledged
(from maximum sample chick count)

3) Successful nests
(=Nest attempts minus abandoned nests)

B. (from A above) calculate:

1) % successful nests

2) Productivity
(=young fledged per nest attempt)

PELAGIC CORMORANT

Nesting effort and productivity summaries:

A. Number of:
1) Nest attempts
2) Young fledged
(from maximum sample chick counts)
3) Successful nests
(=Nest attempts minus abandoned nests)

B. (from A above) calculate:
1) % successful nests
2) Productivity
(=young fledged per nest attempt)

WESTERN GULL

Nesting effort and productivity summaries:

A. Number of:
1) Nesting pairs (SBI, GI)
2) Sample nest attempts-grids (SBI, AI, PI)
3) Sample eggs laid-grids (SBI, AI, PI)
4) Sample eggs hatched-grids (SBI, AI, PI)
5) Sample chicks fledge-grids (SBI,AI,PI)

B. (from A above) calculate (SBI and AI grids only):
1) Mean clutch size
2) Hatch success
(=eggs hatched per eggs laid)
3) Fledging success
(=chicks fledged per eggs hatched)
4) Reproductive success
(=chicks fledged per eggs laid)
5) Productivity
(=chicks fledged per nest attempt)
6) % successful nests

Chick growth calculations:

A. From sample grids on SBI and AI, calculate growth rates (grams per day) for chicks with initial weights of $\leq$100g and at least three weights to $\geq$ 600g.

XANTUS' MURRELET

Nesting effort and productivity summaries:

A. From SBI sample nest areas (Cat Canyon and Tent Slopes):

1) Sample nest attempts
   (=nests with eggs laid plus renesting)
2) Sample nest sites checked
3) Number of successful nests
   (=nests with hatched eggs)

B. (from A above) calculate:
1) Nest occupancy rates
   (=nest attempts per nest sites checked)
2) % successful nests
   (=successful nests per nest attempts)

CASSIN'S AUKLET

Nesting effort and productivity summaries:

A. From PI sample nest boxes:

1) Sample nest attempts
   (=number of nest boxes with eggs laid
   plus renesting)
2) Number of sample nest boxes checked
   (=50)
3) Sample number of successful nests
   (=number of nests with fledged chicks)
4) Sample number of eggs laid
5) Sample number of eggs hatched
6) Sample number of chicks fledged
   (=chicks $\geq$100g)
7) Sample mortality
   a) broken + addled eggs
   b) dead chicks

B. (from A above) calculate:

1) sample % nest occupancy
2) sample % successful nests
   (nests w/fledged chicks per nests checked)
3) sample hatch rate
   (eggs hatched per eggs laid)
4) sample fledge rate
   (=chicks fledged per eggs hatched)
5) sample reproductive success
   (=fledged chicks per eggs laid)

6) sample mortality rates
   a) egg sample mortality rate (=broken/addled eggs per eggs laid)
   b) chick sample mortality rate (=dead chicks per eggs hatched)
   c) total sample mortality rate (=egg+chick mortality per eggs laid)

Sample chick growth calculations:

A. Calculate sample chick growth from chick weights as available.

SNOWY PLOVER

Nesting effort summaries:

1) Total numbers of adult birds in survey areas
2) Total numbers of females in survey areas
3) Total number of paired adults in survey areas
4) Total number of nests found in survey areas.

The data summarized for the parameters listed above should provide sufficient information to detect gross inter-annual changes in nesting populations of these species in the Channel Islands. Over time a sufficient body of data will hopefully be accumulated for more rigorous non-parametric statistical analyses of less obvious trends (see Data Management, above).